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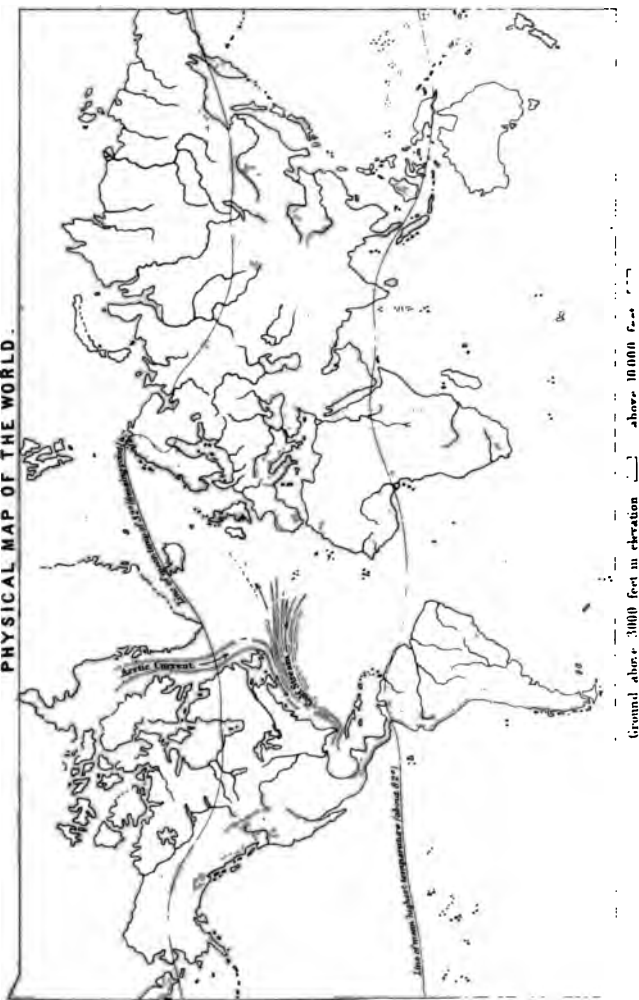
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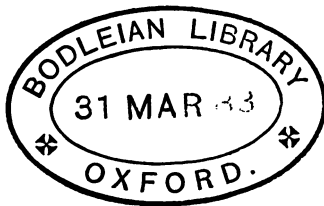
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ELEMENTARY CLASS-BOOK
OF
PHYSICAL GEOGRAPHY.

I.
THE EARTH AS A PLANET.

1. **Physical Geography** is *natural geography*—or the description of the natural world ; that is, the description of its mountains, plains, valleys, rivers, lakes, seas, and also of the climates of various parts of the earth, and of their chief productions, mineral, vegetable, and animal. Such a range of subjects must evidently embrace a vast number of things that have a direct reference to the life and habits of man, and a direct bearing upon his condition as a civilised and social being. For instance, upon the climate of a country will depend its general healthiness or unhealthiness, the kind of clothing which its inhabitants must wear, and a vast number of the every-day habits and customs of life.

2. **The Planets.**—The Earth is one amongst a number of bodies that revolve in elliptical paths or orbits round the Sun. These bodies are called *Planets*.¹ The Earth is the fourth planet in order of distance from the Sun, the planet Vulcan being the first in order, Mercury the second, and Venus the third. At greater distances from the Sun there occur in succession the planets Mars, Jupiter, Saturn, Uranus, and Neptune ; besides a great number of much smaller planetary

¹ Greek, *planetes*, a wanderer.

bodies (distinguished as asteroids¹), which intervene between the orbits of Mars and Jupiter. The bodies here named are called Primary Planets. Some of them are attended by secondary bodies, or *Satellites*,² which move in orbits round their primaries. Thus, the Earth is attended by the Moon, a planetary body which performs a monthly orbit round the earth, and is intimately connected with the movements of the ocean. Mars has two moons, or satellites; Jupiter four; Saturn eight; Uranus four; and Neptune one at least. The Sun, the Planets, and their attendant Satellites, together with the bodies known as Comets, constitute the *Solar System*.

3. The bodies composing the Solar System are but a very few amongst the total number of bright shining points, or *stars*, that are visible on a clear night. The vastly greater number of these—all, indeed, but the planets—are called Fixed Stars, because they always keep the same places relatively to one another. The planets, on the contrary, appear to move *amongst* the fixed stars.

4. **Form and size of the Earth.**—The earth is a globe or sphere in shape—not, indeed, quite round, but a very little flattened towards the poles, somewhat in the way that an orange is, though to a much less extent. The shape is so nearly round that it may be considered as a perfect globe. The *diameter*³ of the earth—i.e., a line drawn through the centre of the globe, from one side to the other—measures, in round numbers, 8,000 miles. The *circumference*⁴ of the Earth—that is, the measure of a line drawn entirely round it—is about 25,000 miles.⁵

¹ Asteroid—Greek, *Aster*, a star—asteroid being used as a diminutive. All the asteroids except Ceres and Vesta are invisible to the naked eye.

² Satellite—Greek, *satelles*, a companion.

³ Diameter—Greek, *diá*, through; *metron*, a measure.

⁴ Circumference—Lat., *circum*, round; *fero*, I carry.

⁵ More exactly, the dimensions of the earth are as follow:—Equatorial diameter, 7,926 miles; Polar diameter, 7,899 miles; mean diameter, 7,912½ miles; circumference, 24,900 miles; area of surface, 196,900,000 sq. miles.

5. **Motions of the Earth.**—The Earth has two kinds of motion—one a rotation, or movement round an imaginary line called its axis,¹ similar to the motion of a top when spinning; the other a motion in a path or orbit round the Sun, the common centre of the planets. The former of these movements is called *diurnal*² (or daily), because it is accomplished once in every twenty-four hours; the latter is called *annual* (yearly), because its completion takes a year. Both movements—the diurnal and the annual—are in constant performance. The Earth's diurnal movement is the cause of day and night. Its annual movement occasions the successive seasons of the year.

6. **Day and Night.**—To understand how the Earth's rotation on its axis occasions day and night, it is only necessary to hold a ball (or globe of any sort, or an apple or an orange), before a lamp or lighted candle in a darkened room; that half of the ball which is *towards* the candle will receive its light, while the other half will be left in darkness. The influence of the Sun upon the Earth is exactly similar, as the following figure will show.

7. It is only from the Sun that the Earth derives its light. If S represent the Sun, and E the Earth, it is clear that half the Earth will be receiving the light of the Sun, while



Fig. 1.



the other remains in darkness.

8. If, while holding the ball before a lighted candle, we turn it slowly round, every part of the surface of the ball will be successively brought within the influence of the light, and afterwards pass again into darkness. In like manner, if we suppose the figure E, in the diagram, to turn round upon its axis, the enlightened half will pass gradually into the place of the darker half, and the reverse.

¹ Axis—Lat., *axis*, an axle-tree.

² Diurnal—Lat., *diurnus*, of or belonging to a day.

9. The Earth's rotation on its axis is performed in an *eastwardly* direction—*i.e.*, the Earth revolves from *west* to *east*. Hence, as the globe turns round, it is (with reference to any supposed point on its surface) the eastwardly portion that first receives the Sun's light; the result is, that the Sun *appears* to rise on the eastern side of the heavens, and to sink on the western side. It is the same with all the other heavenly bodies. The Sun, Moon, and Stars, the whole visible face of the heavens, appear to be carried round the Earth, from east to west, once in twenty-four hours, within which time the periods called Day and Night are successively accomplished.

10. **The Seasons.**—The Earth's annual motion accounts for the successive occurrence of the seasons of Spring, Summer, Autumn, and Winter, in a way which the following diagram (fig. 2) will help us to understand. In this diagram the central figure, S, represents the Sun, and the figures A, B, C, D, four

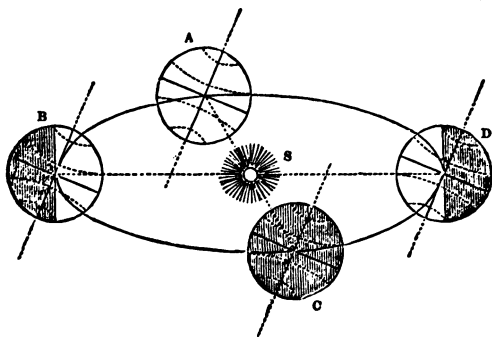


Fig. 2.

positions of the Earth, in the opposite points of its orbit round the sun. Now the axis of the Earth (*i.e.*, the imaginary line round which its daily rotation is performed), instead of being at right angles to the plane of its orbit, is *inclined* to that plane at a certain angle ($23\frac{1}{2}^{\circ}$), and this angle of inclination is

constantly preserved throughout the orbit. This uniform inclination of the Earth's axis in space is shown in the slanting lines—parallel to one another—in the four positions of the Earth, A, B, C, D, in the diagram. In two of these positions, A, and C, the line of division between the light and dark halves of the Earth touches each of the Earth's poles—so that the whole space from pole to pole falls equally either within the enlightened or the dark half of the globe's surface. But in the two other positions, B and D, the line which divides the dark half from the enlightened half differs by an amount of $23\frac{1}{2}^{\circ}$ from the line of the Earth's axis, and hence each pole is left either wholly *within*, or wholly *beyond*, the line of division between light and darkness.

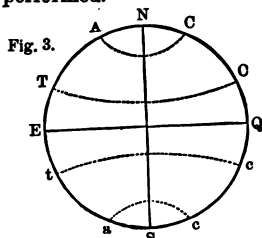
11. The condition here stated explains the unequal length of the days and nights which—in all parts of the earth excepting those immediately under the line of the equator—occur in the course of the year. The positions of the Earth marked A and C in the diagram correspond to the seasons of the spring and autumn equinoxes, when day and night are of equal duration, each being twelve hours long. The position B shows the summer of the northern hemisphere, when long days (and correspondingly short nights) occur within those parts of the globe that lie between the equator and the north pole. The position D is the winter of the northern hemisphere, the season of long nights and short days towards the northern pole. In the southern hemisphere, on the contrary, D is the season of long days and short nights, *i.e.*, of summer ; while B is that of long nights and short days, or winter.

12. The Earth performs a complete passage through its orbit once in every year. The position A is one of equal day and night throughout the globe. While the Earth is passing from A to B, the days are gradually growing of *more* than twelve hours' duration, and the nights *less* than twelve hours long, within the northern hemisphere, while within the southern hemisphere the reverse is the case. At B the mid-summer of

the northern hemisphere, and the mid-winter of the southern half of the globe, are attained. In passing from B to C the days and nights are gradually approaching equality, and the position C is again that of equal periods of light and darkness throughout the earth. From C to D is a period of increasing length of day in the southern half of the globe, and of diminishing periods of daylight to the north of the equator. D is the mid-summer of the southern, and the mid-winter of the northern hemisphere. From D to A exhibits, again, a gradual return towards the condition of equality in the length of day and night. The position A corresponds to the season of spring, in the northern hemisphere; that of C to that of autumn. In the southern half of the globe, on the other hand, the position C is that of spring, and A that of autumn.

13. The following **definitions** should be committed to memory:—

(1.) **The Axis** of the Earth is an imaginary line drawn through its centre, and around which its diurnal rotation is performed.



(2.) **The Poles** of the Earth are the extremities of its axis: one of them is distinguished as the *North*, the other as the *South Pole*. In the figure, No. 3, the line N S represents the axis; N the North pole, and S the South pole.

(3.) **The Equator**¹ is an imaginary circle drawn round the Earth, midway between the poles, and therefore dividing the surface of the Earth into two halves or hemispheres, as the line E Q in the figure.

(4.) **Latitude**² is distance measured from the equator in the direction of either pole: if towards the north pole, it is called *north latitude*; if towards the south pole, *south latitude*.

¹ *Lat., æquo, I make even or equal.*

² *Lat., latitudo, breadth.*

Latitude is expressed in degrees, minutes, and seconds, which are indicated by the signs ° ' " : thus 25° 10' 40" means twenty-five degrees, ten minutes, forty seconds.

Every circle is supposed to be divided into 360°, so that the distance from E. to N., or from E. to S., is equal to 90° (i.e., a quarter of 360°). Hence, the greatest latitude which a place can have is 90°.

(5.) **Parallels of Latitude** are circles drawn round the globe parallel to the equator. On artificial globes they are commonly drawn at 10° apart : on maps, at every 5°, or 2°, or sometimes at every single degree, according to the size and scale of the map.

(6.) **The Tropics**¹ are circles drawn parallel to the equator, at distances of 23½° on either side, as the lines T C, t c, in the figure.² The Northern tropic, T C, is called the tropic of Cancer ; the Southern tropic, t c, the tropic of Capricorn.

The tropics mark the farthest limits within which the Sun is vertical to the Earth's surface, throughout the whole of the Earth's annual path, or orbit. In fig. 2 (p. 4), the position of the Earth marked B shows the Sun as shining vertically over the tropic of Cancer ; in the position D the Sun is vertical over the tropic of Capricorn.

(7.) **The Polar Circles** are lines drawn round the globe, parallel to the equator, at a distance of 23½° from either pole, or 66½° from the equator, as the lines A C, a c, in the figure.² That drawn round the north pole, A C, is distinguished as the Arctic circle ; that round the south pole, a c, is called the Antarctic circle.

The Polar Circles mark the limits within which periods of light or darkness exceeding 24 hours in length occur, according to the Earth's place in its orbit. In fig. 2, the positions of the Earth at B and D show the line of division between the enlightened and the dark halves of the globe as just *touching* the opposite sides of the Arctic and Antarctic Circles, so that the whole of one of those circles falls within the light half, and the whole of the other within the dark half. In the positions A and C the entire space within the Polar Circles is either wholly within the enlightened half, or altogether within the darkened hemisphere.

¹ Greek, *trepo*, I turn.

² Fig. 3, p. 6.

(8.) The tropics and polar circles divide the surface of the Earth into five Zones,¹ called respectively Torrid, North Temperate, South Temperate, North Frigid, and South Frigid.

The *Torrid*² Zone is the space comprehended between the tropics—that is, between the lines T C, t c, in the figure, p. 6. The Sun is always vertical to some part or other of this zone.

The *North and South Temperate*³ Zones are the spaces comprehended between the tropics and the polar circles. Thus the space included between the lines T C, A C, is the North Temperate Zone; that between t c, a c, the South Temperate Zone.

The *North and South Frigid*⁴ Zones are the spaces included within the polar circles. Thus the portion of the globe contained between the line A C and the pole N, is the North Frigid Zone; that between the line a c, and the pole S, the South Frigid Zone.

(9.) A *Meridian*⁵ is a circle supposed to be drawn round the globe in the direction of north and south, passing through the poles, and cutting the equator at right angles.

The outside circle of fig. 3 is a meridian, and a similar circle drawn through any point on the Earth's surface would be a meridian also. Upon artificial globes the meridians are generally drawn at every 10°, or else every 15° apart; on maps, at distances of 5°, 2°, or 1°, according to their size.

(10.) *Longitude*⁶ is distance measured in the direction of east and west from any given meridian chosen for the purpose.

In Britain, the meridian passing through Greenwich (where the National Observatory is situated) is used as a first meridian, and longitude is reckoned in degrees to the east or west of it. Thus, we say a place is so many degrees east of Greenwich, or so many degrees west of Greenwich. The greatest longitude a place can have is 180°, i.e., half-way round the globe, either east or west.

¹ Zone—Greek, *zone*, a belt.

² Torrid—Lat. *torridus*, parched or scorched.

³ Temperate—Lat. *tempero*, I moderate.

⁴ Frigid—Lat. *frigidus*, cold.

⁵ Meridian—Lat. *meridies*, mid-day. Places on the same meridian have mid-day, or noon, at exactly the same time.

⁶ Longitude—Lat. *longitudo*, length. The terms latitude and longitude were applied by the ancients, who thought that the earth extended further east and west than north and south. Hence they supposed the *length* of the earth was from east to west, and the *breadth* from north to south.

(11.) *Zenith* is a term used to express the highest point in the heavens at any place—that is, the point which is vertically over any person, or above his head; *Nadir* indicates the extreme opposite point, or that below his feet.

EXAMINATION QUESTIONS.

1. What is meant by *Physical Geography*?
2. What is a *planet*? Name the planets which belong to the *Solar System*.
3. By what are the planets distinguished from fixed stars?
4. What are *Satellites*? Which of the planets are attended by them?
5. Of what *shape* is the earth? Give in round numbers its dimensions.
6. Distinguish between the two motions of the earth.
7. What changes result from the earth's diurnal and annual motion respectively?
8. Show by a diagram the relative position of the earth and the sun at each of the four seasons.
9. Define briefly the following terms :—axis, poles, equator, latitude, longitude, tropics, polar circles, meridian, zenith, and nadir.

II.

GENERAL FEATURES OF THE EARTH'S SURFACE

1. **Land and Water.**—The whole surface of the globe is equal, in round numbers, to 197,000,000 English square miles. Nearly three-fourths of this surface consists of water—i.e., oceans, seas, gulfs, &c. The whole of the Land amounts to about 51,500,000 square miles.

2. **Distribution of Land.**—The land is unequally distributed over the face of the globe. A map of the world shows this clearly ; so does an artificial globe. There are great masses of land, which we call Continents, in some parts, and smaller portions of land, or Islands, in others ; while over vast portions there is nothing but sea. And the Lands and Seas alike are of very irregular shape. In whatever way we look at the globe this is the case. If we put the globe so that the north pole comes at the top, and the south pole at the bottom (making the line of the equator coincide with the metal or wooden framework of the globe), we see that a much larger portion of the land is in the northern than in the southern hemisphere. If we compare the eastern and western halves of the globe (taking the line of a meridian 20° W. of Greenwich as the division between them), we find more land in the former than in the latter. The globe may even be placed so as to show the inequality still more strikingly. By bringing London to the place of the zenith (so that a circle everywhere 90° distant from London becomes the line of division between the two hemispheres), more than nine-tenths of all the land on the earth is seen to lie within the limits of *one hemisphere*, while the other half is nearly all water.

3. **The Continents.**—These are six in number—Europe, Asia, Africa, Australia, North America, South America. The three first-named are joined together, and form one vast mass of land, called the Old World. The two last-named are also joined together, and are called the New World. Australia, the smallest of the continents, is distinct from any of the others.

4. Europe, Asia, and North America, with parts of Africa and South America, lie within the Northern hemisphere. The Southern hemisphere has only one continent—Australia—entirely within it, but parts of Africa and South America are likewise. Four continents—Europe, Asia, Africa, and Australia—are within the Eastern half of the globe; only two continents—North and South America—within its Western half.

5. **Coast-Lines.**¹—The *contour*, or shape of the land, is very various. Some of the continents have comparatively regular and unbroken coast-lines, with few large indentations. This is the case with Africa, and, in less degree, with Australia and South America. Others, like Europe and North America, display very irregular and broken outlines, with deep gulfs and bays penetrating the shores. Asia partakes of the latter characteristic, but in less measure than either Europe or North America.

6. It is the same with smaller portions of the land. Some have more irregular outlines, and consequently more coast-line, than others. Thus, Britain, Greece, France, Italy, Denmark, are examples of countries with irregular outline or contour of land and sea.

7. Of all the continents, *Europe* comes first in respect of diversified contour and extent of coast-line comparatively to area of surface; *North America*, second; *Australia*, third; *South America*, fourth; *Asia*, fifth; and *Africa*, sixth.

¹ Lat. *costa*, a side.

8. **Highlands and Lowlands.**—The comparative elevation, or *relief*, of the land, equally with its outline, exhibits the most various conditions. In some parts of the earth the land rises into mountains, or extended highlands, (*plateaux*, or *table-lands*); in other parts, forms great plains or valleys, (*lowlands*). Fig. 4, which shows the comparative rise and fall



Fig. 4, Section of the European Continent from S. to N.

of land in passing across Europe from S. to N., or from the Mediterranean to the Baltic Sea, supplies an example of this. In the left-hand portion of the diagram, which corresponds to southern and central Europe, the land forms high mountains and extended plateaux; towards the north and east, it passes into lowland plains.

9. It is in Asia, however, that the highest mountains, and the most widely-extended masses of table-land, are found: South America comes next to Asia in this respect. That is, Asia contains the highest mountains on the entire globe: South America, the highest in the New World.

10. In general, mountain-chains lie not far distant from one of the great oceans, and present a steeper slope on the side which is towards the sea than they do on the opposite or inland side. Thus, the highest mountain-chains of Europe lie near the Mediterranean Sea; those of Asia, not very far distant from the Indian Ocean; and those of South America, near the Pacific. In the case of each there is a short and rapid slope towards the nearer sea or ocean; a long, gradual slope on the *opposite or inland side*.



5. Sketch-Map showing the position of the principal Mountain Ranges of the World.

1. Summary—

- 1.) There is more land in the Northern hemisphere than in the Southern.
- 2.) There is more land in the Eastern hemisphere than in the Western.
- 3.) There are three continents situated wholly to the North of the equator: only one continent wholly to the South of the equator.
- 4.) There are four continents within the Eastern hemisphere: only two within the Western hemisphere.
- 5.) The Atlantic shores of either continent exhibit, in general, greater diversity of outline than belongs to the shores of the other great oceans.
- 6.) Europe has greater diversity of outline (and consequently greater relative amount of coast-line) than any of the other continents; Africa has least diversity in this respect.
- 7.) The land exhibits, in either hemisphere, two slopes—a long and a short slope. In the Old World the longer slope is from south to north; in the New World it is from west to east.

- (8.) The highest mountains in the world are the Himalaya chain, in Asia ; the next in height are the Andes, in South America.

12. The following definitions must be committed to memory :—

(1.) **A Continent**¹ is a portion of land so large as to include several countries, or other divisions, as Europe, Asia, &c.

(2.) **An Island**² is a piece of land surrounded by water, as Great Britain, Madagascar, &c.

(3.) **A Peninsula**³ is a piece of land nearly surrounded by water, as Italy, Spain and Portugal, the Morea, &c.

(4.) **An Isthmus**⁴ is a narrow piece of land which joins a peninsula to the mainland, as the Isthmus of Corinth, which joins the Morea to the rest of Greece.

(5.) **A Plain**,⁵ or **Lowland**, is a portion of land not much raised above the level of the sea, and without any conspicuous elevations on its surface. European Russia is a plain or lowland.

(6.) **A Highland, Table-land, or Plateau**,⁶ is a portion of land raised to a considerable height above the sea. Tibet, in Central Asia, is an example ; so also is the interior of Spain.

(7.) **A Mountain**⁷ is a mass of land which rises above the adjacent plain or valley. Sometimes mountains form detached summits, as Mount Ararat, in Western Asia ; in other cases they form a continuous chain, or series of chains, as the Alps, Himalaya, &c. Most mountain-chains are the borders of plateaux, or table-lands.

¹ Continent—Lat. *con*, together ; and *teneo*, I hold.

² Island—O.-Fr. *igland*, i.e., eye-land ; Lat. *insula*.

³ Peninsula—Lat. *pene*, almost ; and *insula*, an island.

⁴ Isthmus—Greek *isthmus*, the name given to the narrow neck of land which joined the Peloponnesus (or Morea) to the mainland of Greece, near the city of Corinth.

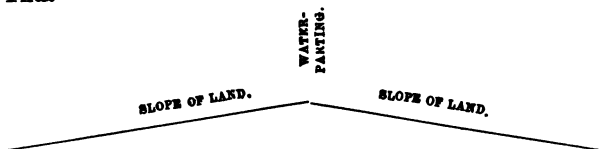
⁵ Plain—Lat. *planus*, flat.

⁶ Plateau—Fr. *plat*, literally, a platform.

⁷ The term *hill* is generally applied to elevations under, and *mountain* to those above, 1,000 feet.

(8.) A **Defile**, or **Ravine**, is a narrow opening between two adjoining mountains; a valley is a broader opening, with sloping grounds on either side.

(9.) A rise of land—whether high, or only of moderate elevation—which determines the flow of running water in opposite directions, is called a **Water-parting** or **Watershed**. Thus—



Sometimes the term *Watershed* is applied, though erroneously, to the slope down which the water flows. This misapplication of the term arises from a misconception of its derivation. The term has been adopted from German geographers. The verb *Scheiden* signifies "to separate," and hence *Wasserscheide*, or *Watershed*, means "water-separation," or "water-parting."

EXAMINATION QUESTIONS.

1. What, in round numbers, is the total area of the surface of the globe? What proportion of this consists of land?
2. Compare the distribution of land in the northern and southern, eastern and western, continental and oceanic hemispheres.
3. Name the six continents. Which form the Old and the New Worlds respectively?
4. Which of the continents possesses the greatest extent of coast-line compared with its area?
5. How are the highlands of the globe placed as a general rule?
6. Give a summary of the main facts relative to the distribution and arrangement of the land.
7. Define briefly and give examples of the following terms:—continent, island, peninsula, isthmus, plain, highland, plateau, mountain, defile or ravine, and watershed.

III

THE HIGHLANDS OF THE OLD WORLD.

1. Plateaux and Mountain-chains are intimately connected, and their linear direction is uniformly the same. They are, in fact, with few exceptions, the terms applied to different portions of the same elevated land-masses. Any extended region of considerable elevation is a plateau or table-land; the external barriers of such a tract of country form, for the most part, mountain-chains. Thus, the Alps form the southward barrier of the Swiss plateau; and the Himalaya Mountains are similarly circumstanced with respect to Tibet.

2. In general, the highlands of the Old World have their greatest extension in the direction of east and west, and they exhibit a steeper descent to the southward than on their northern face. In other words, they slope more rapidly towards the Mediterranean Sea and the Indian Ocean than towards the Atlantic or the Arctic Ocean. They likewise approach much closer to the waters of the former than to those of the latter, exhibiting a short and rapid slope toward the Mediterranean Sea and the Indian Ocean, a long and gradual descent in the direction of the Atlantic and the Arctic Ocean.

3. Plateaux.—The principal are named in the following table :—

		Mean Elevation.
IN EUROPE. {	Central Spain.....	2,000 feet.
	Switzerland & Southern Germany	1,500 feet.
	Norway (southern part of)	4,000 feet.

PLATEAUX (*continued*).

		Mean Elevation.
IN ASIA.	Tibet.....	15,000 feet.
	Mongolia.....	2,000 to 4,000 ft.
	The Deccan.....	2,000 to 3,000 ft.
	Afghanistan.....	6,500 feet.
	Persia.....	3,000 feet.
	Armenia.....	6,000 feet.
	Asia Minor.....	2,000 to 4,000 ft.
	Arabia.....	3,000 to 4,000 ft.
IN AFRICA.	The Sahara, or Desert.....	1,500 feet.
	Abyssinia.....	6,000 feet.
	Great African Plateau.....	3,000 feet.

4. The cold and treeless tableland of Central Spain is by far the largest in Europe. The great plateaux of Asia are much more extensive, and far loftier. They comprise an area nearly twice that of Europe, and range in height from 2,000 to upwards of 17,000 feet. In Africa, the great desert of the Sahara is, for the most part, an upland of from 1,500 to 3,000 feet in height, while the whole southern interior has an average elevation of 3,000 feet. The lofty plateau of Abyssinia lies between the Upper Nile and the Red Sea.

5. **Mountains.**—Mountains exhibit great diversity of form, and, of course, impart corresponding variety of shape and aspect to the valleys which they enclose. Some mountains rise with a steep ascent, exhibiting precipitous sides, while others display gentler slopes, the valley passing by insensible degrees into the hill-side, and the hill into the mountain. The summits, again, exhibit, in some instances, rugged and shapeless masses of rock; in others a rounded or dome-shaped elevation, or a flattened and table-shaped surface, like a truncated cone. The Table Mountain, at the Cape of Good Hope, is one example of the latter description; and Mount Tabor, in the Holy Land, is another. There are many such in India, their tops crowned with fortresses.

6. These and other varieties of aspect are intimately connected with the geological structure of the mountain-region—that is, they are due to the kind of rock-strata of which the mountain-mass consists. Every kind of rock formation—granite, trap (or volcanic rock), limestone, chalk, or alluvial deposit—has its characteristic external form. Chalk, for example, is uniformly accompanied by the swelling rounded forms which are found in the scenery of Kent, Surrey, and the south-eastern parts of England in general. Deep glens and abrupt precipices, on the contrary, characterise the mountain regions of Wales, Cumberland, and North Britain, where the older and harder stratified rocks are found.

7. **Mountain Passes.**—The passes which traverse mountain-chains, and the defiles or ravines by which they are approached, form a noteworthy condition of physical geography, and are highly deserving of study. The passes over the Himalaya Mountains lie at heights of 15,000 feet and upwards: some of those over the Alps reach more than 11,000 feet. The possession of these passes (or *gates*, as they are sometimes termed) has often proved of great importance in warfare, and the feasibility of traversing them is of still greater moment in connection with the carrying on of commercial intercourse between the nations dwelling upon opposite sides of a mountain-chain.

8. **Explanation of Terms.**—The term “mountain” is generally applied to elevations above 1,000 feet, and may denote isolated heights, or the more conspicuous parts of a chain. The former are nearly always volcanoes, or of volcanic origin, and are consequently of comparatively rare occurrence; the latter forms by far the most common aspect of elevated ground. Geographers generally designate a series of connected elevations, if *in the same line*, a “mountain range”—if irregularly arranged, but still near each other, a “mountain group.” A series of mountain ranges generally parallel to one another forms a “mountain chain;” and a series of ranges and groups

of mountains, having the same general direction or position, forms a "mountain system."

9. **Mountain-Systems of the Old World.**—Looking at the Old World as a whole, we find that it has in reality but *one* great mountain system—extending in an almost unbroken line from Cape Roca, the most westerly point of Europe, to East Cape in Siberia, the most easterly point of the Asiatic continent—a distance of not less than 9,000 miles. The most important portions of this great mountain belt are the Alps in Europe, and the Himalaya in Asia.

10. **Mountain-Systems of Europe.**—Commencing in the south-west, we have first the *Iberian System*, consisting of several parallel ranges, traversing the Spanish tableland, and rising in the Sierra Nevada far above the snow-line. The lofty and rugged chain of the *Pyrenees* extends across the broad isthmus which connects the peninsula to the European mainland. The great *Alpine System* embraces not only the Alps proper, but also the Carpathians, Balkans, Apennines, and other adjoining ranges. The **Alps** are the loftiest and most magnificent mountains in Europe, and fill a place in its geography similar to the Himalaya in that of Asia. They stretch in a semicircle round the head of the Italian peninsula, and give off branches in many directions. From the central ridge of the St. Gothard the various sections of this great range may be easily traced on the map. The highest summit of the Alps—Mont Blanc¹—attains an elevation of 15,780 feet, or nearly three miles above the sea level. The snow-line here descends to 8,000 feet, so that all the higher Alps are constantly covered with snow. For beauty and variety of scenery the Alps are probably superior to any other range in the world. Vast glaciers fill the higher, and magnificent lakes many of the lower, valleys. The larger glaciers are found on the northern side of the range; those on the southern or Italian side are much smaller. Some of the Alpine glaciers descend

¹ "The white mountain."

the valleys to as low a level as from 3,000 to 4,000 feet above the sea, and are thus found in immediate proximity to the vineyard and the cornfield. The *Carpathians* form a semi-circle, 900 miles long, enclosing the great plain of Hungary. They are not so lofty as the Alps, but much richer in minerals. From the *Balkans*,¹ which form the eastern offshoot of the Alps, a chain extends south, finally terminating in Cape Matapan, the most southerly point of the European continent. The Apennines stretch southwards through the entire length of the Italian peninsula. Near Naples is the famous volcano of Vesuvius; further south, in Sicily, the isolated cone of Etna rises to a height of nearly 11,000 feet above the sea, being thus the highest volcano in Europe.

11. The *Scandinavian Mountains* have some conditions which distinguish them from either of the mountain-regions above-named. The whole of Norway (the westerly division of Scandinavia) is a vast mountain, the western face of which descends with a rapid, in some cases precipitous, slope, into the adjacent ocean. The water penetrates the narrow valleys by which the mountains are there intersected, and forms the numerous *fjords* of the Norwegian coast. The snow-line is found in the southern part of Norway at heights of 4,000 to 5,000 feet—at a less elevation farther to the northward. There are glaciers of large size within parts of Norway.

12. The *British System* comprises the various ranges, which extend, with little interruption, from the extreme north of Scotland to Land's End in England. The Northern Highlands and Grampians in Scotland contain several peaks above 4,000 feet high; the Pennine range, Cumbrian group, and the Snowdon range in England, are less elevated; Snowdon, the highest point, being only 3,570 feet above the sea.² None of

¹ Turkish, meaning "high ridge."

² Mont Blanc, the highest peak of the Alps, is more than four times, and Mount Everest, the extreme summit of the Himalaya, about eight times the height of Snowdon.

the Irish mountains rise to any great height ; some of them, however, are extremely beautiful. Among those of Kerry are the picturesque Lakes of Killarney.

13. The *Ural Mountains*, unlike nearly all the other ranges of Europe, run almost due north and south. The chain is of great length,¹ and very rich in minerals, but it is generally low, round-topped, with no lofty peaks or rugged precipices like the Alps.

14. **Mountain-Systems of Asia.**—The chief mountain ranges of Asia may be divided into three great systems—the *Western*, embracing the various ranges of Asiatic Turkey and Persia ; the *Central*, consisting of the vast series of highland masses which fill great part of Central Asia ; and the *Eastern*, comprising the whole of the ranges of Eastern Asia, from East Cape to Cape Romania.

15. Of the western system we shall only mention the *Taurus* and *Anti-Taurus*, which form the border of the great table-land of Asia Minor. The famous Mount Ararat, a lofty and almost perfect cone, lies almost equally distant from the Caspian, Black Sea, Mediterranean, and Persian Gulf. The *Caucasus*, like the Ural, forms one of the natural boundaries between Europe and Asia, but otherwise it more closely resembles the Pyrenees. Like that chain it extends across a broad isthmus -- is broken by few passes—its highest peaks are isolated cones. The main ridge is upwards of 10,000 feet high, while the snow-line rises from 9,000 feet in the west to 12,000 feet in the east. Loftier than the Alps, the Caucasus Mountains are much less picturesque, having no grand glaciers or beautiful lakes like those which have made Switzerland the “playground of Europe.”

16. Of the great ranges which form the central system, the most conspicuous are the *Himalaya Mountains*,² which

¹ 1,200 miles.

² Sanskrit, *him*, snow ; and *alaya*, place—thus meaning the place or abode of snow.

form the southern face of the lofty plateau of Tibet. The whole length of the Himalaya is 1,500 miles, and the breadth of the mountain-mass is from 200 to 250 miles. Along the southern base of the chain, throughout, there stretches a belt of swamp and jungle, called the Tarai, which, during great part of the year, is exceedingly unhealthy. Above this belt the mountains rise gradually, range above range, with successive terraces between, until at length the region of snow-covered peaks is attained. A vast number of these peaks exceed 20,000 feet, and several are upwards of 24,000 feet. *Mount Everest*,¹ the highest, is 29,000 feet above the sea. *Dapsang*, in the north-western portion of the mountain region, and reaching 28,278 feet, comes second in height. *Karakorum Peak*, 28,265 feet, and *Kinchin-jinga*, 28,156 feet, come next in order of altitude.

17. The snow-line varies in the Himalaya between 15,000 and 18,000 feet. It is higher on the northern than on the southern face of the mountains (contrary to what is generally the case in mountain-ranges that are within northern latitudes), chiefly because of the greater quantity of snow that falls on the southward face of the mountains. Glaciers on a scale of vast magnitude—greatly surpassing the glaciers of the Alps—abound within the higher parts of the mountains.

18. Of the eastern system, the so-called *Yablonoi* and *Stan-ovoi Mountains* are continuations of the *Altai Mountains*, and mark the southern border of the great plain of Siberia. Further south, the two great ranges of China, the *Pe-ling* and *Nan-ling*, are situated respectively north and south of the Yang-tze-kiang. It is said that the Nan-ling, or Southern Mountains, are in some parts covered with perpetual snow.

¹ The height of Mount Everest is equal to about one *fifteen-hundredth* part of the length of the earth's diameter, and would be represented on the largest of our artificial globes by a minute grain of sand. So little do the loftiest elevations on the earth's surface detract from the sphericity of the entire mass of the globe. The altitude of this mountain was first determined by Colonel Everest, hence its name.

19. **Mountain-Systems of Africa.**—It is worthy of note that all the great mountain ranges of the African Continent are for the most part parallel to, and near, the coast. Thus we have in the north the great chain of *Mount Atlas*, stretching along the coast through Morocco, Algeria, and Tunis, and rising in some parts upwards of 10,000 feet. Parallel to the western coast also are the *Kong Mountains*, which nowhere exceed 3,000 feet in height. At the head of the Bight of Biafra the volcanic group of the *Cameroon Mountains* attains in Mount Albert a height of 13,700 feet. In the extreme south of the continent are a series of parallel ranges, of different elevations, marking the edges of the remarkable "terraces" of this region. The highest point, however, scarcely reaches a height of 8,000 feet, or little more than one-third of the altitude of Kenia and Kilimandjaro, the loftiest peaks of the eastern ranges. The great plateau of Abyssinia, between the Red Sea and the Upper Nile, is also crossed by several lofty ranges, which are frequently intersected by tremendous ravines, often of appalling depth.

EXAMINATION QUESTIONS.

1. What connection can be traced between plateaux and mountain-chains?
2. What is the general direction of the highlands of the Old World?
3. Name the principal tablelands in Europe, Asia, and Africa, and give the mean elevation of each.
4. "Mountains exhibit great diversity of form." Note the most common forms.
5. From what causes do mountain-passes derive their importance?
6. Explain the terms mountain, mountain-group, mountain-chain, mountain-system.
7. Point out on the map the position and direction of the great mountain-system of the Old World.
8. Name and give a brief description of the chief mountain-systems of Europe.
9. What distinguishes the Scandinavian Mountains from the other European ranges?
10. Name the three great mountain-systems of Asia.
11. Where is Mount Ararat? Name the four seas from which it is equally distant.
12. What is the general character of the Caucasus?
13. Describe the Himalaya Mountains.
14. Name some of the other ranges of Asia.
15. What general law obtains with regard to the position of the chief mountain-ranges of Africa?

IV.

THE HIGHLANDS OF THE NEW WORLD.

1. **Plateaux.**—The principal table-lands of the New World are :—

		Mean Elevation.
NORTH AMERICA.	Utah.....	5,000 feet.
	Mexico	7,000 „
CENTRAL AMERICA...	Guatemala, &c.	3,500 „
SOUTH AMERICA.	Quito (Ecuador)	9,000 „
	Pasco.....	11,000 „
	Titicaca	13,000 „
	El-Despobaldo.....	13,000 „
	Brazil, interior of	1,500 „

2. **Mountains.**—Nearly all the mountain-ranges of the New World lie in the general direction of N. and S. The only exceptions are found in the mountains of Venezuela and Guiana (South America), and in some of the low ranges of hill that cross the plateau of interior Brazil. Some of the most elevated summits of North America, however, consist of detached conical peaks (of volcanic origin, and many of them active volcanoes), which rise above the plateau of interior Mexico.

3. **Mountain-Systems of North America.**—The two principal mountain-systems of North America are the Rocky Mountains and the Alleghany.

4 The *Rocky Mountains* lie towards the western side of the American continent, though at a distance of several hundred miles from the shore-line of the Pacific. They extend from

the shores of the Arctic Sea on the N. to the parallel of 30° on the S.—a range of nearly 3,000 miles. The middle portions of the chain attain the greatest height, several of the summits lying between the parallels of 33° and 52° being upwards of 13,000 feet in height, and a few points upwards of 15,000. The highest is Mount Brown, 15,900 feet. The higher summits throughout rise above the snow-line. The whole space intervening between the Rocky Mountains and the Pacific Ocean is filled by a series of highlands and mountains, the latter forming in many cases distinct ranges in the neighbourhood of the coast. The chain called *Sierra Nevada*, which borders the plateau of Utah on the west, reaches above 10,000 feet in height.

5. The *Alleghany Mountains* belong to the E. side of North America, and are within the United States. They include a number of parallel ridges, lying N.E. and S.W., and divided by narrow valleys. The average height does not exceed from 2,500 to 3,000 feet, but the highest summits exceed 6,000 feet.

6. The volcanic peaks which are found in Mexico and the countries of Central America reach a greater height than any of the points among the Rocky Mountains. Thus, the summit of Popoca-tepetl (a name which signifies “smoking mountain”) is 17,773 feet above the sea; and Orizaba, or Citlal-tepetl (“star mountain”), 17,373 feet. But the base from which these mountains rise is itself several thousand feet above the sea-level, so that their real elevation is much less.

7. **Mountain-Systems of South America.**—South America includes the Andes, the Mountains of Guiana, and the Mountains of Brazil. The two last-named lie chiefly towards the eastern side of the continent. The Andes, which are the highest and most important amongst the mountain-systems of the New World, are on its western side, and are nowhere far distant from the Pacific.

8. The *Andes* extend through the whole length of South America, from the shore of the Caribbean Sea southward to

Cape Horn. They include, in general, two (in some parts three, and even four) parallel chains, with high valleys and plateaux between. The plateaux of Quito and Titicaca are bordered on either hand by the highest summits of the mountain-system: Chimborazo, Cayembe, Cotopaxi, and other lofty summits adjoin the former; Lirima, Sahama, Sorata, and Illimani, are grouped around the latter.

9. It is usual to divide this vast mountain-system (with reference to the countries through which it extends), into the Columbian, Peruvian, Bolivian, Chilean, and Patagonian Andes. To the south the mountain called Aconcagua, in the Chilean Andes (on the border-line of Chili and La Plata), is the highest measured summit, and reaches 23,910 feet above the sea. But the culminating point of the Andes is *Sorata*, 24,812 feet, on the eastern side of Lake Titicaca. The height of the chain diminishes greatly to the southward of Chili, and the mountains finally sink below the sea in the islands of Tierra del Fuego, and the adjacent rocks that terminate in Cape Horn.

10. Since the Andes lie in the direction of north and south, the height of the snow-line (which varies with the latitude) is, of course, different in different parts of the range. Under the equator, perpetual snow is found in the Andes at 15,800 feet above the sea; in the Bolivian Andes, the height of the snow-line is still greater, ranging from 16,000 to 18,000 feet. In the Chilean Andes it gradually declines from 14,000 to 6,000 feet. The passes over the mountain-region lie in some cases at heights of 12,000 feet and upwards.

11. The Andes coincide throughout with a line of volcanic agency. They include a greater number of active volcanoes than any other mountain-regions on the globe, and the countries which they traverse are uniformly liable to shocks of earthquake—sometimes of terrible intensity.

EXAMINATION QUESTIONS.

1. Name the chief *plateaux* of the New World, and state the mean elevation of each.
2. What is the general direction of the mountain-ranges of the New World? Give examples.
3. Describe briefly the two chief mountain-systems of North America.
4. Give the elevation of some of the volcanic peaks in Mexico.
5. There are three systems of mountains in South America. Name them, and mark their positions on the map.
6. How are the Andes generally divided? Name the highest summit. What is the height of the snow-line in different parts of the range?

V.

LOWLAND-PLAINS.

1. The transition from the mountain to the plain or valley, though sometimes abrupt, is more frequently gradual. The lowlands stretch out from the base of the mountains, gradually declining towards the ocean, upon the distance of which their relative slope depends. It is through the lowland-plains¹ that the principal rivers have their courses, and they form in many cases the most populous regions of the globe.

2. Lowland-Plains of Asia.—Among lowland-plains of Asia are the following :—

- (1) Plain of the Euphrates and Tigris (ancient Mesopotamia and Babylonia).
- (2) Plain of Hindostan, or Northern India.
- (3) Plain of Pegu (Indo-Chinese Peninsula).
- (4) Plain of Siam (do.)
- (5) Plain of Tonquin (do.)
- (6) Plain of North-Easter China.
- (7) Plain of Siberia.
- (8) Plain of Turkestan.

3. The three first-named of the above slope southwardly, and are watered by rivers that flow into the Indian Ocean. The succeeding three are watered by rivers that belong to the Pacific basin. The plain of Siberia slopes northwardly, and its rivers are directed to the Arctic Sea. The last-named region—Turkestan—is an inland depression, its rivers terminating in the Aral Basin.

¹ *Lat. planes, flat, broad.*

4 Plains of Europe.—The principal lowland-plains of Europe are the following :—

- (1) The Great Plain of Eastern Europe (Russia).
- (2) Plain of Northern Germany and the adjacent Low Countries (Netherlands).
- (3) Plain of Languedoc, or Southern France.
- (4) Plain of Andalusia, or South-Western Spain.
- (5) Plain of Lombardy, or Northern Italy.
- (6) Plain of Hungary, or the Middle Danube basin.
- (7) Plain of the Lower Danube (Wallachia and Bulgaria).

5. The first-named of the above comprehends half the European continent, extending from the White Sea on the N. to the Black and Caspian Seas on the S., and from the Ural Mountains to the shores of the Baltic. In the latter direction it is continuous with the plain of Northern Germany and the adjacent Netherlands. The south-eastern portions of this region comprehend the **steppes**,¹ or grassy plains of southern Russia, which stretch along the shores of the Black and Caspian Seas, and thence into the adjoining parts of the Asiatic continent.

6. The plain of Languedoc coincides in great part with the valley of the river Garonne; the plain of Andalusia, with the basin of the Guadalquivir; Lombardy, with the valleys of the Po and Adige.

7. Plains of America.—The lowland-plains of the New World are on a vaster scale than those of the Old World—Siberia alone excepted. The whole interior of both North and South America is a vast succession of lowland-plains, watered by rivers on a scale of corresponding magnitude. The rivers supply the readiest means of distinguishing their various portions :—

(1.) The plain of the *Mississippi* is the region of **prairies**² which lie chiefly on the western side of the Mississippi, and extend from the river to the Rocky Mountains. They

¹ A Tartar term for an open, treeless plain. ² French, *prairie*, a meadow.

consist of undulating plains, gradually increasing in elevation towards the west. They are covered with long, rank grass, blended with flowers, which are chiefly of the lily kind. They are, however, in rapid process of being brought under the plough.

(2.) The plain of the *Orinoco* is occupied in great part by vast *llanos* (*i.e.*, levels), or savannahs, which are grassy regions, almost as level as the sea, and varied only by gently swelling eminences called "mesas," or by low flat terraces, five or six feet in height. In the rainy season the plains are flooded, but in the dry season the verdure is burnt up by the heat.

(3.) The plain of the *Amazon* is characterised by *selvas* (*i.e.*, forest-plains), which occupy the lower portions of its basin, towards the immediate banks of the great stream and its tributaries. Almost the entire area is densely timbered, and the trees are so matted together by creeping and trailing plants, that the country can only be penetrated by sailing up the Amazon or its affluents. The largest trees bear brilliant blossoms of every hue, mingled with every shade of green, while the creeping and air plants are covered with flowers of the most vivid colour.

(4.) The plains of the *La Plata* valley (Parana and Paraguay) are known as *pampas*, which are grass-covered regions of vast extent. Many districts of the pampas vary with the seasons in their aspect. In winter, all is verdure; in spring, the clover, which has been abundant, vanishes, and gigantic thistles spring up to the height of ten or twelve feet, and are in full bloom. In summer, the thistles are burnt up by the heat, and the region looks withered and barren. In autumn, the clover springs up, and all is verdure again.

EXAMINATION QUESTIONS.

1. What is meant by a *lowland plain*?
2. Name the chief plains of Asia, and find out from the map the principal rivers which traverse them.
3. Name the great plains of Europe, and the rivers which water them.
4. Where and what are the *steppes*?
5. What is the main difference between the lowland plains of the Old and those of the New World?
6. By what names are the different plains of the New World generally known?
7. Give some account of the *prairies*. To what river-basin do they belong?
8. Describe briefly the *llanos* of the Orinoco valley.
9. What is the general aspect of the *selvas* of the Amazon basin?
10. Where are the *pampas*? Give some account of them.

VI. DESERTS.

1. Many regions, some among them of vast extent, are called by the term *desert*. The aspects of these are strikingly various. Some are rocky or stony deserts; others dry, heathery and gravelly tracts; while some (and those the worst) consist of sandy plains. In some cases, again, the desert coincides with a region of high plateau; in others, with tracts of depressed lowland. The deserts of the Old World are very much more extensive than those of the Western continents, on account of the greater dryness of the former; since it is absent of water (and especially of perennial streams) that gives to the desert its worst characteristics. Wherever running water, even a perennial spring, is found in the desert, an oasis is occasioned. The oasis¹ is a verdant spot in the midst of the surrounding wilderness, the verdure being due to the unfailing supply of moisture.

2. **Deserts of the Old World.** The most extensive deserts are those of Asia and Africa, which form a vast and nearly continuous belt of the Old World, stretching from the borders of China and Manchooria to the shores of the Atlantic. They are enumerated below.

(1.) **Desert of Gobi, or Shamo,**² in Central Asia. It extends over great part of Mongolia: the Gobi is, for the greater part, a region of grassy plain, though sandy tracts occur

¹ Greek, *oasis*; originally the name of an "island" in the "Sea of Sand" in North Africa. Some say that it is derived from a Coptic term, signifying "resting place."

² *Gobi* is the Mongolian word for "desert." *Shamoo*, Chinese, means "sea of sand."

the localities. It is exposed, from its elevation, to great extremes of temperature, the cold of winter being terribly severe.

2.) **Deserts of Turkestan**, lying E. and S. of Lake Aral. They include the tracts known as Kara-kum¹ and Kizil-kum,² which are divided by the course of the river Syr, or Jaxartes; also the desert of Kharezm, or Khiva, adjoining the course of the river Oxus.

A traveller thus describes the journey through these wild regions. For many miles the sand was hard, like a floor, over which we pushed at a rapid pace. After this we found it soft in places, and raised into mounds of little mounds by the wind. Our horses were now changed, in an hour these mounds were passed, when we were again on a good pace, riding hard. . . . Hour after hour went by, and our steeds had been changed a second time. . . . In our route there was nothing visible—it was still the same plain; there was not so much as a cloud floating in the air, that, by casting a shadow over the steppe, could give a slight variation to the scene. . . . The whole horizon was as flat as a glass, but neither man, animal, nor bird, could be seen. . . . We rode on for several hours, but there was no change of aspect. One spot was so like another that we seemed to make no progress. . . . No landmark was visible, no rock protruded through the sterile soil; neither thorny shrub nor flowering plant appeared, to indicate the approach to a habitable region; all around was 'kizil-kum' sand.")

1.) **Great Indian Desert**, or *Thar*. This includes a large tract on in the N.W. of India, between the lower Indus and the upper portion of the Ganges valley.

2.) **Desert of Seistan**, to the S. and E. of Lake Zurrah, in the south-west part of Afghanistan.

3.) **Desert of Mekran** (Beluchistan), extending along the coast of the Indian Ocean.

4.) **Great Salt Desert of Persia**, including the central and eastern interior of the Persian table-land.

5.) **Desert of Mesopotamia** (Al-Jezireh), between the rivers Tigris and Euphrates.

¹ Kara-kum, black sand.

² Kizil-kum, red sand.

(8.) **Syrian Desert**, embracing the eastern or inland part of Syria, from the Euphrates to the mountain tracts that adjoin the Mediterranean.

(9.) **Arabian Desert**, embracing great part of Arabia. In the N.W. is Arabia Petræa (the rocky Arabia), which includes the Sinai region: the more central region forms the high plateau of Nedj, which consists chiefly of gravelly plains.

(10.) **Egyptian and Nubian Deserts**, between the Red Sea and the valley of the Nile.

(11.) **The Sahara**,¹ or Great Desert of Africa, a vast region stretching across the breadth of Africa, from the valley of the Nile to the Atlantic; in the direction of N. and S. it reaches from the Mediterranean Sea and Mount Atlas to Lake Chad and the valley of the Niger. The extreme dimensions of the Sahara are 3,000 miles from E. to W., and from 800 to 1,000 miles N. and S.

(12.) **Kalahari Desert**, in S. Africa, to the northward of the Orange river.

3. Few, if any, of the above regions are altogether destitute either of vegetation or inhabitants. Scarcity of water, which is found only in a few wells or pools, at long intervals apart, is the worst condition common to all of them, more so in the case of the Sahara than in any of the others. The Syrian and Mesopotamian Deserts are only barren during the season of intense summer heat, exhibiting abundant verdure during other portions of the year.

4. **Deserts of the New World**.—In the New World there are few large tracts correspondent to the deserts of the Eastern continents. The most noteworthy are: (1) the *Plateau of Utah*, or basin of the Great Salt Lake, to the W. of the Rocky Mountains; (2) the *Bolson de Mapimi*, in the northern interior of the Mexican plateau; (3) the desert of *Atacamá*, on the west side of South America, between the Bolivian Andes and

¹ Arabic, *the desert*. In pronouncing this word the accent should be laid on the first syllable, the second *a* being short, thus, *Sáhara*.

the Pacific; and (4) some of the interior plains of the La Plata country, between the river Parana and the Andes, in portions of which there are salt-water lakes, without any outlets.

EXAMINATION QUESTIONS.

1. Define the term "*desert*." What is the general and worst characteristic of all deserts?
2. Point out on the map the position of the most extensive deserts of the Old World.
3. Where are the following deserts :—Gobi, Kara-kum, Kizil-kum, Great Indian Desert, Deserts of Seistan and Mekran, Great Salt Desert, the Sahara, and the Kalahari Desert?
4. What is the general aspect of the deserts of Turkestan?
5. What is the extent of the Sahara?
6. Name and point out on the map the position of the principal deserts of the New World.

VII.

THE OCEAN.

1. The Ocean¹ covers nearly three-fourths of the earth's face. It forms a vast and continuous body of water, by which the whole of the land is insulated. The great land-masses, however, are so placed as to divide the waters into three great basins, to which the names of Atlantic, Pacific, and Indian, respectively given. The portions of sea that lie in the division of either pole are distinguished by the terms Arctic and Antarctic. There are thus five Oceans. The Arctic Ocean, however, may be regarded as an extension of the Atlantic basin, though Behring Strait connects it also with the Pacific. The Antarctic Ocean is connected equally with each of the three great ocean-basins.²

2. Everything connected with the great ocean—its depth, composition of its waters, temperature, and movements—is not only important in itself, but also of the greatest interest to those who desire to have an adequate conception of the natural condition of the earth's surface.

3. Depth.—The depth of the sea has formed within recent years a subject of the most careful and repeated inquiry. Numerous soundings³ have been taken over vast areas of

¹ Ocean—Greek, *okeanos*.

² The Atlantic, Pacific, and Indian Oceans have no natural limit to the south; they are *supposed* to extend to the Antarctic Circle, which forms the nominal limit of the Antarctic Ocean. This great belt of water, extending without interruption from land, round the globe south of the 35th parallel, is frequently called the *Southern Ocean*.

³ Especially by the *Challenger* Expedition, 1872-6. Full particulars of the methods of "sounding" will be found in the larger "Class-Book of *Physical Geography*." (London: George Philip & Son.)

ocean, both in the vicinity of the land and in the deep, open waters, hundreds of miles away from land. It has thus been ascertained that the forms of relief exhibited by the land are continued beneath the waters of the ocean, the bed of which exhibits a similar variety of hill and valley, depressed plain and raised tableland. But the floor of the ocean is far more regular than the surface of the land, and, except in coralline or volcanic areas, it nowhere presents the abrupt descents and steep precipices so common on land. The general results of the soundings taken in all parts of the ocean show that the deepest portions of the sea-bottom are, generally speaking, as much below the surface as the highest portions of the land are *above* the same level. The greatest depth yet recorded, however, falls short by about 1,400 feet of the highest elevation on land.¹ But the general depth of the ocean is much greater than the average elevation of the land. Particulars as to the actual depth and form of each of the great oceans will be found further on, and need not therefore be given here.

4. **Temperature.**—The *temperature* of the sea is distinguished by its uniformity—its average, at or near the surface, being generally about the same as the mean temperature of the air in the correspondent parallel, while it undergoes much less variation with day and night, or with the recurring seasons, than the atmosphere does. The temperature everywhere falls with increasing depth. The lowest layer of water throughout the ocean, except in a few enclosed basins, is, even under the equator, nearly at, and occasionally below, the freezing point. This cold water at the bottom of the sea is an underflow from the polar basins, principally from the Antarctic, as the Arctic Ocean is really open only to the Atlantic.

5. **Saltness.**—The *saltness* of the sea is one of its best-known properties, and, as well as its bitterness, is due to the various salts which it holds in solution. Of these salts, muriate of soda (common salt) holds the largest place. The

¹ Mount Everest, in the Himalayas, 29,000 feet.

total proportion of saline matter contained in sea-water is about three and a-half per cent.—*i.e.*, estimating any given quantity of water by its density or weight, about three and a-half parts in every hundred consist of particles of salt, which would be left behind if the water were evaporated.¹ The quantity of salt which the sea holds in solution is not everywhere the same. Some seas, like the Baltic, are freshened by the influx of numerous rivers. The Mediterranean, on the other hand, is saltier than the ocean.

6. **Specific gravity.**—The *specific gravity* of sea-water is greater than that of fresh water—a natural result of its saltiness. Sea-water is hence more buoyant than fresh-water, as any one who has bathed in the two may readily have distinguished. The Mediterranean Sea has a higher specific gravity than the ocean at large, and also greater buoyancy. The Dead Sea (an inland lake, the water of which is intensely salt) is greatly more buoyant than either.

7. **Colour.**—The *colour* of the sea—a pale green in the neighbourhood of the land—becomes more blue with increasing depth, and in the midst of the great ocean is of a deep indigo hue. The Mediterranean is noted for the deep blue of its waters. The Red Sea, notwithstanding its name, is blue within its middle and deeper portions; it is only near the shores, among the coral reefs which abound there, that it merits the epithet of “red,” that tinge being imparted to the water by countless abundance of minute animalcules, visible only with the aid of the microscope. A like cause accounts for the various shades of colour sometimes observable in other parts of the ocean.

¹ A great deal of the salt used for household purposes in some countries, as in Spain and Portugal, and the Mediterranean coasts in general, is obtained by evaporating the sea-water—admitted for the purpose to shallow excavations in the land (*salines*), and exposed to the hot rays of a southern sun. Salt is similarly obtained upon some parts of the English coast (*Fasex, Hants, and elsewhere*), but the vastly larger portion of our supply is derived from the *brine-springs and rock-salts* of Cheshire and Worcestershire.

8. **Luminosity.**—A recent writer¹ thus graphically describes it:—"We have seen it fitfully gleaming over the sleeping waters, and again gilding with burning light every wave and ripple within sight. Sometimes so pale as to seem spectral in its whiteness; sometimes glowing in a ship's wake so powerfully that books may be read by its light. At times it studs the sea like myriad water-stars, and on pouring the water through the hands the fiery points will adhere to the fingers, glowing all the while. Great globes of living fire well up from beneath the ship's keel, or irregular patches constantly changing in outline float around. Every now and then a flash of fire is propagated across the surface, and all remains dark until illuminated by another similar display." This luminous appearance, generally of a pale greenish colour, is due to the presence near the surface of vast numbers of various minute luminous animals, and is more perceptible on a dark night, when the water is perfectly calm.

9. **Movements of the Ocean.**—The waters of the Ocean are always in motion: the winds producing *waves*; the attraction of the Moon, and in a less degree the Sun, causing the *tides*; while the difference in temperature and density is the chief cause of those grand movements known as *currents*.

10. **Waves.**—The most frequent cause of disturbance in the surface of the sea is found in the winds, which sometimes raise a mere ripple upon the waters, while at others they lash them into fury, raising the great waves which accompany the storm. The height of waves generated in the open ocean, where there is no obstruction to their onward movement, is much less than in the case of a rocky coast, or pier, or resisting body of any kind. The advancing body of water seems to the mariner (especially when his vessel is within the trough or hollow between two adjacent waves) of vastly greater height than really belongs to it. The average height of the Atlantic waves does not exceed twenty-four feet from trough to crest, or half that elevation

¹ Mr. Skertchley.

above the *mean* level of the waters. The mean highest waves, during a long-continued gale, have been found to reach forty-three feet above the trough of the sea. The interval between successive waves is found, under the same conditions, to be about 600 feet, and their rate of advance equal to thirty-two miles an hour.

11. **Tides.**—The Tides occasion a periodical change in the level of the ocean, high and low water succeeding one another, along lines of sea-coast in general, at intervals of about six hours. The cause of these movements is astronomical: they are due to the attraction exerted by the Moon (and, in a less degree, by the Sun also) on the waters of the globe. The tidal wave, however, is materially influenced in its actual direction and rate of movement by the irregular shape of the land, as well as by the depth of the sea, and other conditions. The vast expanse of the Southern Ocean (where alone the waters form a continuous belt around the globe) is the region within which the wave of high water, which twice a-day visits our shores, is derived—travelling with steady (though not everywhere uniform) movement over the intervening seas. Lines drawn so as to connect places which at new and full moon have high water at the same hour, are called *co-tidal* lines. These, however, are only of limited importance in the study of Physical Geography.

12. **Currents.**—A continuous movement within the sea—that is, a continued flow of its waters in some given direction—constitutes a current. There are such movements in many parts of the great oceans, as well as in inland seas. A current may be likened to a river, on a scale of magnitude vastly greater than that of even the largest rivers: it is a *stream in the ocean*, as a river is a stream on the land. Currents are of the highest importance to navigators; they accelerate or retard the course of ships, according as the vessel is sailing with or against the ocean-stream.

13. The main cause of currents is to be found in the differ-

ences of temperature which obtain in the surface-waters of different latitudes, due to the various amounts of solar heat received in torrid, temperate, or frigid regions respectively. The warmer the water, the less its density. The colder and denser water of high latitudes has a tendency to sink, and the warmer and lighter water of intra-tropical seas to spread over the surface; in the same way that two fluids of different densities (as oil and water), if placed in one vessel, will ultimately arrange themselves—the heavier at the bottom, and the lighter at the surface, of the vessel in question. A continual flow and reflow in the waters of the globe is thus generated.

14. Many other causes conspire to influence the direction of currents, and to prevent the waters of the ocean from attaining a condition of rest. The rotation of the earth on its axis is one of these. The various rates of motion which belong to different latitudes modify the direction which the currents would assume were the earth at rest, deflecting them from due north and south, the courses inclining either to the east or west of the meridian.¹ The shape of the land, and the particular

¹ A point on the earth's surface under the equator moves from west to east more rapidly than a point under the parallel of 10°; a point under the parallel of 10° more rapidly than one under the parallel of 20°, and so on, since the same period of rotation (twenty-four hours) is common to all latitudes. Thus, under the 60th parallel, the rate of axial motion is only half that at the equator: in other words, a point on the earth's surface at the equator is carried round in an eastwardly direction at a rate equivalent to 1,000 miles per hour (24,000 miles ÷ 24), while a point under the parallel of 60° has a corresponding movement of only 500 miles per hour. This different rate of eastwardly movement under different parallels influences in an important degree the courses of currents (both of air and water) moving in the direction of the meridian—i.e., from N. to S., or the reverse. A current moving *from the equator towards the pole* sets out with an initial *eastwardly* tendency which is greater than that of the regions through which it passes; its *eastwardly* inclination is thus in continual advance, and its actual direction becomes a compound of its meridional movement and its eastwardly (or axial) tendency—i.e., it becomes N.E. instead of due N. On the other hand, a current moving *from the pole in the direction of the equator* has its eastwardly (or axial) tendency at a rate which is less than that proper to the regions into which it advances; hence it lags, or falls behind the movement proper to the lower parallels, and actually its course becomes, in the northern hemisphere, S.W. instead of due S.; in the southern hemisphere, N.W. instead of due N.

form and depth of the ocean-bed, in different localities, are also modifying influences which affect the direction of currents. The greater amount of evaporation in some parts of the sea over other parts requires also to be taken into account: thus, the great evaporation from the surface of the Mediterranean necessitates a constant in-flowing current, through the Strait of Gibraltar, to supply the waste.

15 Principal Currents.—The principal currents of the ocean are enumerated in the following table:—

1. CHIEF CURRENTS OF THE ATLANTIC OCEAN.

- (1.) The *Equatorial Current*, setting from E. to W.
- (2.) The *Brazilian Current*, a branch of the preceding, setting along the coast of Brazil to the south-westward.
- (3.) The *Guinea Current*, setting from N. to S., along the coast of Western Africa.
- (4.) The *Gulf Stream*, flowing to the eastward, or from S.W. to N.E.

2. CHIEF CURRENTS OF THE PACIFIC OCEAN.

- (1.) The *Equatorial Current*, setting from E. to W.
- (2.) The *Antarctic Current*, setting to the N.
- (3.) The *Peruvian Current*, setting from S. to N.
- (4.) The *Cape Horn Current*, setting to the E.
- (5.) The *Japanese Current*, setting from W. to E. and N.E.
- (6.) The *Mexican Current*, setting along the coasts of Mexico and Central America, its direction alternating with the seasons.

3. CHIEF CURRENTS OF THE INDIAN OCEAN.

- (1.) The *Equatorial Current*, from E. to W.
- (2.) The *Agulhas (or Lagullas) Current*, from E. to W.
- (3.) The *Southern Connecting Current*, from W. to E.

4. CHIEF CURRENT OF THE ARCTIC OCEAN.

- (1.) The *Arctic Current*, setting from N. to S.

5. CHIEF CURRENT OF THE ANTARCTIC OCEAN.

- (1.) The *Antarctic Drift Current*, setting from S. to N.

16. **General direction of Currents.**—It thus appears that the general direction of ocean-currents, within *tropical* latitudes, is to the *westward*; within *temperate* latitudes, to the *eastward*. In the *higher latitudes* of either hemisphere, the direction is *from the pole towards the equator*.

17. Having thus described the Ocean as a whole, we proceed to give a few particulars of the principal features of each of its five great divisions.

18. **The Atlantic Ocean.**—The Atlantic¹ Ocean has the form of an immense valley, lying in the direction of north and south, and exhibiting a series of great curves, something in the form of the letter S. In its widest part it is upwards of 5,000 miles across. It is distinguished especially by the great number of inland seas, gulfs, bays, and other inlets connected with it, and by the great extent of coast-line which it consequently possesses—much greater, relatively, than belongs to either of the other oceans. The Mediterranean Sea, the Baltic Sea, Hudson Bay, with their various gulfs and offsets, as well as the Gulfs of Mexico, St. Lawrence, and Guinea, the Bay of Biscay, the Caribbean Sea, and numerous others, all belong to the Atlantic basin.

19. The bed of the Atlantic seems to be divided into two great longitudinal valleys, by a ridge which runs from Greenland southward. This ridge, called the *Dolphin Rise*, seems to have a singular uniformity of height, having only 1,600 fathoms of water on its crest from the Azores to the latitude of the Hebrides, where it rises gradually, and culminates above water in the volcano of Hecla in Iceland. The eastern valley has an average depth of 2,000 or 3,000 fathoms. The western valley is deeper, and widens considerably in the neighbourhood of the Bermudas, which form but the summit of a submarine mountain. The telegraphic plateau, across which several submarine cables have been laid, extends from Iceland to Newfoundland, a distance of 1,640 miles, with a

¹ So called from Mount Atlas, in North Africa.

depth averaging from 10,000 to 12,000 feet.¹ The greatest depth in the Atlantic (3,875 fathoms) has been found between St. Thomas Island and the Bermudas. The average depth of this ocean is probably less than three miles. It is worthy of note that the seas between England and the continent are so shallow, that, were their level to fall 100 fathoms, the British Isles would be connected by dry land with France, Holland, and Denmark, and separated from Norway only by a very narrow channel.

20. The Currents of the Atlantic have been already named. Nearly all of them branch from the Great Equatorial current, which, sweeping across the ocean from east to west, divides off Cape St. Roque, sending one branch south along the Brazilian coast. The main stream, however, holds on north-west, entering the Caribbean Sea, and making the circuit of the Gulf of Mexico, flowing thence through the Strait of Florida as the *Gulf Stream*—the most important and powerful of the Atlantic currents. It owes its name to the fact of its issue from the Gulf of Mexico; thence it flows, in a N.E. direction, along the coast of the United States, as far as Cape Hatteras (lat. $35^{\circ} 13'$), where it strikes off to the E., and is traceable as far as the southern edge of the banks of Nantucket and Newfoundland (between 48° and 60° W. of Greenwich). There it interlaces with the cold-water current from Baffin Bay, and is gradually lost in the general north-eastwardly drift of the ocean within the middle latitudes of the North Atlantic.

21. The Gulf Stream is distinguished by its superior warmth, as compared with the ocean at large, as well as, in its origin, by the deep indigo hue of its waters, and by the great rapidity

¹ A very general opinion prevails that the ocean floor frequently presents enormous precipices or "walls." This, except in volcanic or coralline, is not generally the case: the bottom of the sea being on the whole gently undulating. Professor Huxley remarks that if it were a mere question of gradients, a wagon could be driven along the sea bottom from Ireland to Newfoundland.

of their movement. This rapidity becomes gradually lost as the stream widens out after its eastwardly course from the coast of the North American continent. It is, however, appropriately called "a river of warm water, flowing between banks of colder water on either hand." It is no doubt of much importance as a local current, but the influence commonly attributed to it as an agent in modifying the climate of western and north-western Europe is greatly exaggerated—if not, indeed, altogether imaginary. The north-eastwardly 'set' of the tropical Atlantic (under the influence of the earth's axial motion, combined with the northward flow of the warm surface-water within low latitudes) sufficiently accounts for the condition referred to.

22. The *Arctic Current* of the Atlantic, which is also an important and powerful stream, has an opposite influence upon climate. It brings down from Baffin Bay vast quantities of loose floating ice, with huge icebergs, and carries a low temperature to the coast of Labrador, and the lands adjoining the Gulf of St. Lawrence.

23. The *Pacific Ocean*.—The Pacific Ocean is larger than the united Atlantic and Indian Oceans, and covers a larger area of the globe's surface than all the continents and islands together. It is above 12,000 miles across (nearly half the circumference of the globe) in its widest portion, under the line of the equator. The shape of the Pacific is that of a vast circular basin, with high mountain chains bordering, for the most part, its shores. There are no inland seas, properly so called, belonging to it. The China and Japan Seas, with those of Okhotsk and Kamtchatka, belong to its western and northern sides, and the Gulfs of California and Panama form offsets of its eastern waters.

24. This ocean is distinguished from the other great basins by the immense number of islands, some of volcanic origin, and the rest of coral formation, which are scattered over its vast expanse. It is also not only much larger, but also deeper

than the Atlantic Ocean: the greatest depth yet recorded, 4,600 fathoms, or 27,600 feet, was found off Japan. The two branches of its Great Equatorial current are separated by a smaller counter-current. The northern branch flows into the deep basin between the Philippines and Japan, whence it issues as the powerful and rapid *Japan Current*, the "Gulf Stream of the Pacific." The *Mexican Current*, flowing along the western coast of Mexico and Central America, varies its course from south-east in winter to north-west in summer.

25. **The Indian Ocean.**—The Indian Ocean is the smallest of the three great oceans, and differs from the other two in the fact of its being limited by land to the northward. It has two considerable inland seas—viz., the Red Sea and the Persian Gulf—besides numerous bays and smaller extensions, of which the Bay of Bengal is the most important. The Straits of Malacca and Sunda, which connect the Indian Ocean with the China Sea, and Torres Strait, which unites the Indian and Pacific Oceans, are among the most important inter-oceanic channels on the globe.

26. The greatest known depth in the Indian Ocean is scarcely more than 3,000 fathoms, and its general depth appears to be much less than that of the Atlantic or the Pacific. Being closed by land north of the equator, its currents are also inferior in magnitude and importance. The drifts in the Arabian Sea and the Bay of Bengal vary their direction according to the monsoons, which blow alternately, for six months, from the north-east and south-west.

27. **The Arctic Ocean.**—The Arctic Ocean is a circular and nearly land-enclosed basin, bounded by the northern coasts of Europe, Asia, and North America. It opens to the North Atlantic by a wide sea between Norway and Greenland, upwards of 1,000 miles across. It is connected with the Pacific by a narrow strait about sixty miles wide. Of the many inlets and inland seas which belong to this ocean we need at present *only mention the White Sea in Europe, and Baffin Bay and*

the adjoining seas and channels of Arctic America. The latter have been repeatedly explored for the purpose of discovering the "North-West Passage." Although traced out, it is impracticable. More recently still the "North-East Passage" has been successfully accomplished, but under conditions that must make its frequent repetition a matter of great difficulty and danger. Many intrepid explorers have also pushed their way north towards the pole. The furthest northerly point yet attained was reached by a sledge party under Commander Markham, in 1876.

28. **The Antarctic Ocean** has no definite natural boundaries like the Arctic, but is supposed to include all the waters within the Antarctic Circle. It has been less frequently visited than the North Polar Sea, so that the space which it covers on the map is for the most part blank. It is also more difficult of approach, and its numerous icebergs are found ten degrees nearer the equator than those of the Arctic Ocean.

EXAMINATION QUESTIONS.

1. What proportion of the earth's surface is covered by the ocean, and into what basins is it divided?
2. What is the greatest depth yet found?
3. Is the floor of the ocean, generally speaking, similar in relief to the surface of the land?
4. By what is the temperature of the sea distinguished?
5. What proportion of saline matters is contained in sea water?
6. What do you know of the *colour* and *luminosity* of the sea?
7. Name the three kinds of movements observable in the ocean.
8. What is the general height of waves in the open ocean?
9. To what cause are the tides due?
10. What are currents? What is the main cause of currents?
11. What effect has the earth's rotation on the direction of currents?
12. Name the principal currents in each of the great oceans.
13. What laws govern the general direction of currents?
14. Give some particulars of the Atlantic Ocean.
15. What distinguishes the Pacific Ocean from the Atlantic?
16. Describe briefly the Indian Ocean. In what respect does it differ from the Atlantic and Pacific Oceans?
17. Give some account of the North and South Polar Seas.

VIII.

RIVERS AND LAKES.

1. **A River** is a stream of water flowing through the land, and therefore passing from a higher to a lower region. Most rivers are discharged, ultimately, into the sea or ocean ; but some rivers have their final outlet in salt-water lakes, unconnected with the sea. A very small stream of running water is called a rivulet, brook, or torrent. A river which unites its waters with a stream of larger size is said to form an *affluent*, or *tributary*, of the latter.

2. The *valley* of a river is the tract immediately adjacent to the course of the stream. The term *river-basin* has a more extensive significance ; it indicates the whole area of country watered by a river and its tributaries. Thus, the *valley* of the Thames implies merely the low ground through which the Thames flows ; but the *basin* of the Thames includes also the valleys of the Cherwell, Kennet, Wey, Lea, and other affluents of the main stream—*i.e.*, the whole tract of country within which the running waters are directed towards the Thames, and are ultimately discharged through its channel.

3. The rising ground which divides one river-basin from another, and down the opposite slopes of which the water flows in opposite directions, is called the *water-shed*, or *water-parting*. In some instances the water-parting is formed by high mountains ; in others, it consists merely of a plain of trifling elevation.

4. Many rivers, as they approach the sea, divide into two or more branches : the tract of land which these branches enclose is called a *delta*. Thus, we speak of the delta of the Nile, the

delta of the Rhone, Ganges, &c. Other rivers, like the Thames, the Mersey, the Humber, La Plata, &c., form *estuaries* at their junction with the sea.

5. River-Systems.—All the rivers which directly or indirectly flow into the same ocean are said to form the *river system* of that ocean. Of the four great oceans the Atlantic receives by far the greater number of the large rivers of the globe. This naturally results from the fact that the longer slopes of the land, both in the Old and New World, are directed towards the Atlantic, or the contiguous basin of the Arctic Sea. A much smaller number of large rivers flow into the Pacific Ocean, while the Indian Ocean receives the drainage of a still smaller area. The drainage of nearly the whole of the northern regions of Europe, Asia, and America falls into the Arctic basin, which is, however, merely an extension of the Atlantic. Besides these a large area of the Old World is watered by rivers that terminate in salt-water lakes, never reaching the ocean. This region of inland drainage includes the Caspian and Aral basins, with the rivers Volga, Ural, Amoo, and Syr. Two similar (but much less extensive) regions are found in the New World: one of them comprehends the basin of the Great Salt Lake, in North America; the other that of Lake Titicaca, in South America.

6. The Arctic River-System.—The rivers which flow into the Arctic Ocean from Europe are few in number, and of no great importance.¹ The longest of them, the *Petchora*, flows directly into the ocean; the next in length, the *Dwina* and *Onega*, enter the White Sea. From Asia the Arctic Sea receives the great rivers which flow north through the vast plains and inhospitable "Tundras" of Siberia. The *Obi*, *Yenesei*, and *Lena* are frozen over for several months in the year; their upper courses are always free from ice long before their middle and lower portions, hence the periodical floods to which they are subject. But in spite of these drawbacks they are regularly

¹ For a tabulated list of rivers belonging to each system, see Appendix B.

navigated during the brief summer by steam vessels. The American section comprises one stream of upwards of 2,000 miles in length. This magnificent river, the *Mackenzie*, so called after its gallant explorer, Alexander Mackenzie, who discovered it in 1789, has its remote sources near Mount Brown, in the Rocky Mountains, and carries to the sea the surplus waters of several large lakes. Its lower course is frozen over for three-fourths of the year, and its basin is, for the most part, a trackless waste.

7. **The Atlantic River-System.**—This system is the river system of the globe, surpassing the other systems in the number and size of its rivers, and the extent of land which it drains. The Atlantic receives either directly or indirectly most of the larger rivers of all the continents, except Asia and Australia. In Europe, the Rhine, Rhone, and Danube; in Africa, the Nile, Niger, and Congo; in North America, the St. Lawrence and the Mississippi; and in South America, the Orinoco, Amazon, and La Plata are among the most prominent examples of the rivers which belong to the Atlantic system.

8. **The Rhine**, with its numerous tributaries, drains an area of more than twice the size of Ireland, one-sixth of which is within Switzerland, one half within Germany, and the rest within France and the Low Countries. The basin of the Rhine consists of three well-marked divisions:—(1) That of the Upper Rhine, from its source in the higher Alps to Basel, well described by a French geographer as an almost circular tract, surrounded by a dense ridge of mountains, abounding in peaks, lakes, and streams, where there are but few plain lands and these of small extent, and where the valleys alone open up communication. (2) That of the Middle Rhine, from Basel to Wesel, one of the richest and most densely peopled districts in Europe, traversed by mountain chains parallel to the course of the river, of which the most remarkable are the Vosges and the Black Forest, enclosing the river in a long and narrow valley of great fertility and most picturesque appearance. (3) The

of the Lower Rhine, from Wesel to the Sea, broad and level, without enclosing heights, open on every side, covered with water and marshes, broken into fragments by inundations of the sea, and of which the parts near the sea are below the level of high water, the climate unhealthy in many places, the land abundantly watered by innumerable canals and streams, almost everywhere fertile and well cultivated.

9. The *Rhone* rises also in the Alps, on the west side of Mont St. Gothard, about 18 miles distant from the source of the Rhine. It carries down to the Lake of Geneva a vast amount of mud, but leaves it beautifully clear; it is a splendid navigable stream, but with a rapid current, being, indeed, the most impetuous river in Europe.

10. The *Danube* is the second longest river in Europe. Its immense basin is enclosed by the Alps and Balkans on the south, and the German Mountains and Carpathians on the north. The upper portion of its course lies through a moderately elevated upland—its middle and lower basin comprises the great plain of Hungary, and the lowlands of Roumania and Bulgaria. It is said to discharge into the sea upwards of twenty million cubic feet of water per minute—more than all the other rivers flowing into the Black Sea.

11. The *Nile* is not only the longest, but also the most important and interesting of the great rivers of Africa. It receives all its affluents in the upper half of its course—from the junction of the Atbara to the sea, a distance of more than 1,200 miles, it does not receive a single tributary. Its lower basin is thus very narrow, and almost confined to the tract periodically inundated by its waters.

12. The periodical rise of the middle and lower Nile is due to the abundant seasonal rains of Abyssinia, in which the Blue Nile has its origin. The White Nile, rising in an equatorial lake-region, with a rainfall of ten months' duration, is an unfailing and nearly uniform source of supply to the united stream; but the Blue Nile and the Atbara, periodically swelled by a

heavy rainfall of three months, give origin to the floods which annually inundate the Egyptian plain. At Cairo (a short distance above the head of the Delta) the river begins to rise about the end of June, and continues to increase daily until towards the close of September, at which time nearly the whole valley, and the greater part of the Delta, is under water. After remaining stationary for a few days, it retires gradually within its proper channel, leaving on the ground which it has covered the fertilizing slime or Nile mud, to which the abundant harvests of Egypt are due. In seasons when, as is occasionally the case, the waters fail to reach their proper height, and consequently do not remain sufficiently long upon the ground, a failure in the harvest is the certain result.

13. The two great rivers of Western Africa, the *Niger* and *Congo*, are among the longest rivers of the globe—the former having a course of at least 2,300 miles, and the latter of nearly 3,000 miles. The delta of the Niger is much larger than that of the Nile, but is nearly everywhere covered with a dense growth of tropical vegetation. The Congo is scarcely inferior to the Nile in length, but discharges into the sea a much greater volume of water—its estuary being a broad channel, ten miles wide.

14. The only great river flowing directly into the Atlantic from the North American continent is the *St. Lawrence*, which forms indeed one of the most important physical features of the New World, on account of the great chain of lakes with which it is connected, and of which it forms the outlet. These lakes—Superior, Michigan, Huron, Erie, and Ontario—have together an area of more than 90,000 square miles, which exceeds that of the island of Great Britain. The river *St. Lawrence*, which issues from the lower end of Lake Ontario, carries their surplus waters to the sea, and becomes, in the latter part of its channel, a vast estuary, gradually increasing from twenty-five to a hundred miles in width.

15. The *Mississippi*, “father of waters”—such is the mean-

ing of the name—rises in Lake Itasca, within the heart of the great American plain, and has a southward course of 2,400 miles to the Gulf of Mexico. Midway on this course it receives on its right bank the longer stream of the *Missouri*, which comes from the Rocky Mountains, and flows 2,500 miles (in the general direction of south-east) ere it joins the *Mississippi*. Measuring from the mouth of the *Mississippi* upward to the point of junction, and thence by the *Missouri* to the source of the latter, the whole length of river-channel is upwards of 4,000 miles.

16. The river *Amazon*, which waters the great South American plain, has a length of channel nearly equalling that of the *Mississippi*, and drains a still more extensive area of country, its basin embracing two and a half millions of square miles. The river *Maranon*, which rises in the small lake of *Lauricocha*, among the high plateaux of the Peruvian Andes, is generally regarded as the main stream of the *Amazon*, though the *Ucayali*, and others of its tributaries, which come from a more southern source, are of equal (or perhaps greater) length. The *Madera*, which unites its waters to those of the *Amazon* 700 miles before the latter reaches the sea, has a length of more than 2,000 miles above the junction, and several others among its tributaries would be accounted rivers of first-rate magnitude in any other region. The breadth of the *Amazon* increases in the lower portion of its course from five miles to upwards of fifty miles. The tide is perceptible at *Obydos*, more than 400 miles above the sea, and even in the smaller affluents of its great tributaries, at distances of above 500 miles inland.

17. The *Orinoco*, another of the great South American rivers, exhibits the curious feature of a bifurcation in its stream, throwing off from the main channel a branch which joins the river *Negro*, an affluent of the *Amazon*. This branch, which bears the name of *Casiquiare*, leaves the *Orinoco* about 130 miles below the source of the latter, amidst the mountains of

Guiana, and has a length of nearly 200 miles before it joins the river Negro. Two great river-basins are thus united by natural means, so that a boat might pass from the mouth of the Orinoco into the river Negro, thence into the Amazon, and down the latter stream to its outlet,—thus making the circuit of a large portion of the South American continent, and passing round the extensive region of the Guiana mountain-system.

18. The *Rio de la Plata* is the common estuary of the Parana and Uruguay: the immense volume of water forms a perceptible fresh-water current at a distance of 100 miles out at sea.

19. **The Pacific River-System.**—The Pacific system is inferior to that of the Atlantic, both in the number and magnitude of its rivers and the extent of its drainage. From America only one first-rate river, the *Yukon*, enters the Pacific. This great stream is upwards of 2,000 miles long, but is free from ice only for four months in the year, and its basin is, for the most part, a mere hunting ground for a few hundred Indians. On the side of Asia, however, are several magnificent streams, one of which, the *Yang-tsze-kiang*, rises in the mountain region of Tibet, and has a course of 3,200 miles before it reaches the sea, the latter portion of its course being through a rich alluvial plain, the most fertile and populous portion of the Chinese empire. Frequent changes take place in the islands and banks that occur in its bed, the result of the vast quantity of sediment with which its immense volume of water is charged, and the great force of the stream. Changes of a still more extensive character have also occurred in the course of the *Hoang-ho*, or Yellow River. This stream (2,600 miles in length) burst through the artificially-formed mounds which the continued deposit of ages had rendered necessary for the confinement of its channel, and now enters the Gulf of Pechelée through the channel of the *Ta-tsing-ho*, two hundred miles to the northward of its former outlet. Off the former mouth of the river

—now dry, or nearly so—its sands stretch seaward for upwards of a hundred miles, rendering it dangerous for large ships to approach that portion of the coast. In the course of this change it has destroyed a large portion of the Imperial Canal, hitherto the great highway for the conveyance of grain to the Chinese metropolis.

20. **The River-System of the Indian Ocean.**—The Indian Ocean is bounded on three sides by, and receives numerous rivers from, three of the continents, Australia, Asia, and Africa.

21. Of the Australian rivers the *Murray*, and its chief tributary, the Murrumbidgee, are perennial streams, the rest of its tributaries are, for the most part, mere surface torrents supplied by the rains, and, consequently, during seasons of drought they are speedily dried up or converted into a chain of pools. During the rainy seasons they are subject to sudden and violent floods.

22. The Asiatic rivers belonging to this system are numerous and important. The *Brahmaputra*, the most easterly of the three great rivers which derive their chief supplies from the Himalayas, is, notwithstanding its superior length and volume, far less important than the *Ganges*, the work done by which, “as the water-carrier and fertilizer of the densely populated provinces of Northern India, from its source in the Himalayas to its mouth in the Bay of Bengal, entitles it to rank as the foremost river on the surface of the globe, and fully excuses the affectionate reverence and divine honours paid to it by the Hindus. A great river like the *Ganges* has three distinct stages in its life from its source to the sea. In the first stage it dashes down the mountain sides, cutting out for itself deep gullies in the solid rock, and ploughing up glens and ravines on its way. The second stage is where it emerges from the mountains on to the plain, running then more peaceably along the valleys, and seeking out for itself the lowest levels. Here it receives the mud and drainage of the country round, absorbs tributaries, and rolls forward with an ever-increasing volume

of water and silt. Finding its speed checked by the equal level of the plains, and its bed raised by its own silt, it splits out into channels, like a jet of water suddenly obstructed by the finger, or a jar of liquid suddenly dashed upon the floor. Each of the channels thus formed throws out in turn its own channels to right and left. In the case of the Ganges, the country which these many offshoots enclose forms the delta of Bengal."

23. The *Indus*, the great river of Western India, like the Ganges and Brahmaputra, also rises in the Himalayas, but at a much greater elevation. It carries to the sea four times as much water as the Ganges, but its arid and thinly-peopled valley contrasts strongly with the populous and fertile valley of the latter river.

24. Of the rivers of Eastern Africa the largest is the *Zambesi*, which rises, under the name of Leeba, in Lake Dilolo. Its upper course is broken by numerous falls and rapids; the most remarkable are the magnificent Victoria Falls, discovered by Livingstone. Its delta, which is larger than that of the Nile, is periodically inundated.

25. **Inland Drainage.**—Of the rivers which belong to the areas of inland drainage, the longest and most important is the *Volga*, which, rising in the Valdai Hills at an elevation of only six hundred feet above the level of the Caspian, into which it flows, has an extremely gentle current, and, being unobstructed by rocks or falls, is navigable almost to its source. In winter it is frozen over, and sledges and carriages take the place of steamers and boats.

26. **Lakes.**—Lakes are nearly always connected with rivers; often, indeed, they are merely expansions of a river-bed, due to the peculiar shape of a particular portion of its valley. This, however, is far from being always the case. Most lakes receive one or more streams of running water from adjoining high grounds, and the greater number of them also give issue to a stream. This is the case with the English, Scotch, and

Irish lakes, and also with those of Switzerland, Sweden and Norway, European Russia, and Canada. Lakes of this description have nearly always fresh and sweet water. There are numerous lakes, however, which have no outlet or channel of discharge, although many of them receive a constant influx of water through running streams. The Caspian Sea (which is really a vast lake) is of this kind; so is the Dead Sea, in Palestine. Lake Urumiyah, in Persia: Lake Van, on the high plateau of Armenia; the Great Salt Lake, west of the Rocky Mountains; and many others, are of like description. The water of such lakes is in nearly all cases salt. The Dead Sea and the Lake of Urumiyah are amongst the saltiest bodies of water on the globe.

27. **Fresh-water Lakes.**—The largest *fresh-water* lakes on the globe are found in Canada, and the neighbouring United States, viz.:—Superior, Huron, Michigan, Erie, and Ontario—a vast continuous chain of inland waters, of which the river St. Lawrence constitutes the outlet. The largest fresh-water lake in the Old World is Baikal,¹ in Siberia, from which the river Angara (an affluent of the Yenesei) issues. The large lakes of Central Africa—the Victoria Nyanza,² Albert Nyanza, Tanganyika, and Lake Nyassa, are also of fresh water. The Victoria and Albert lakes belong to the basin of the Upper Nile. Lake Tanganyika was formerly supposed to have no outlet; it is now known that its surplus waters are carried into the Congo or Livingstone River by the Lukuga. Lake Nyassa is drained into the Zambesi by the Shire.

28. **Salt Lakes.**—The largest *salt* lake on the globe is the Caspian Sea. Lakes of this description are much more numerous in the Old World than in the western half of the globe, and are especially so within the high central region of the Asiatic continent.

¹ The "Holy Sea" of the Russians.

² "Nyanza," of which "Nyassa" is merely another form, is a general term for lakes, large or small.

EXAMINATION QUESTIONS.

1. Explain the terms tributary, river-basin, water-shed, delta, estuary. Give some examples of rivers that form deltas.
2. Define the term river-system. Which of the great oceans receives the largest number of rivers?
3. Name the larger rivers flowing into the Arctic Ocean.
4. What distinguishes the Atlantic system from the other river-systems of the globe? Give examples of the rivers flowing into the Atlantic, or some of its inland seas.
5. Give a short account of the Rhine, Rhone, and Danube.
6. Briefly describe the Nile and its annual inundations.
7. Name the two largest rivers flowing into the Atlantic from Western Africa.
8. Give some account of the St. Lawrence, noting the great lakes of which it forms the outlet.
9. Describe briefly the other great rivers of America—Mississippi, Amazon, and La Plata.
10. Name the three longest rivers belonging to the Pacific system. Give a few particulars of each of them.
11. Point on the map to the chief rivers entering the Indian Ocean.
12. Give some account of the Murray, Brahmaputra, Ganges, Indus, and Zambezi.
13. Into what two great classes may lakes be divided? Name a few examples of each class.

IX.

THE ATMOSPHERE.

the air, or atmosphere, is an invisible fluid, which every-
 surrounds the globe, covering land and sea alike ; and
 ry to the support of life, both vegetable and animal.
 st its properties is that of density, or weight. Air
 upon every object a pressure which, at the average level
 sea, is equal to about fifteen pounds to the square inch.¹
 essure, however, is not everywhere the same in amount,
 ; the level of the sea. It becomes gradually lessened
 crease of elevation, as the lower and denser strata of
 ple body of air are passed through ; the amount of pres-
 ence always less at the summit of a hill than at its
 In like manner, the temperature of the air undergoes
 al diminution with successive ascent to its higher
 and the air at the top of a hill is hence always cooler
 its base. The rate of this progressive decrease does
 wever, follow any uniform law.

anything which sets air in motion renders its presence
 ately sensible. When perfectly at rest we are uncon-
 of its presence, though inhaling (and again expelling) it
 very breath we draw ; but directly anything imparts
 to the air, we feel the movement, and are rendered con-
 of its force. Wind is simply air put in motion. Any
 tion or expansion in the volume of air, consequent upon

barometer measures the varying amount of this pressure, by means
 sight to which it supports a column of mercury. The *thermometer*
 the varying heat of the air, in virtue of its property of expansion—
 on of mercury in the tube of the thermometer expanding with heat
 racting with cold.

change of temperature, disturbs the equilibrium of the whole body of air, and occasions a wind. Air becomes lighter in proportion as it is warmer; hence, in any body of air, if one portion has its temperature raised, it acquires a tendency to rise, while the cooler and heavier portions of the surrounding air press in to take its place. An ascending current of warm air, and one or more horizontal currents of colder air, are thus generated.

3. The relative dryness or moisture of the air is also a condition that affects its density, and consequently tends to set its different portions in motion. Any accession of moisture lessens the pressure of the atmosphere, hence a falling barometer indicates rain.

4. The Winds that occur within the warmer latitudes of the globe are more easy of explanation than those which occur within higher parallels, because of their greater uniformity and steadiness, owing to the intenser conditions of solar heat within and near the tropics. Within some portions of the globe the wind is a constant phenomenon, blowing uniformly (or nearly so) from one quarter of the heavens; in other regions it exhibits a periodical alteration, blowing for half the year from one direction, and for half from another quarter. Elsewhere, again, a condition of almost uniform calm, or absence of wind, prevails.

5. **The Calm Latitudes.**—The space marked on the physical map of the world as the “Zone of Calms,” is a narrow belt extending across the Atlantic and Pacific Oceans, in the immediate neighbourhood of the equator. Its breadth averages about six or seven degrees. It lies chiefly (within the Atlantic, wholly) to the northward of the equator, owing to the preponderance of land within the northern half of the globe.

6. The breadth of this zone undergoes some variation, its limits on either side becoming extended or contracted with the place of the sun to the north or south of the equator. When the sun is in north declination, the influence of its vertical *heat upon the northern half of the torrid zone extends the*

belt of calms several degrees northward of its limit at the opposite season of the year: similarly, when in south declination, the direct solar heat causes this zone to range several degrees farther to the southward. It is therefore in reality an *oscillating* belt, rather than a space confined within the definite limits necessarily given to it upon the map. It is a region dreaded by the mariner, on account of the delays, often very tedious, which it opposes to his progress. But the prevailing calm of this belt is occasionally interrupted by sudden and violent gales, under the influence of which the vessel passes through it, and attains a region where steady and uniform currents of air prevail.

7. The prevailing calms in the neighbourhood of the equator are a consequence of the nearly uniform heat which obtains within the more central portion of the torrid zone, and where, consequently, there is little disturbance (in so far as temperature is concerned) in the general equilibrium of the air. The Indian Ocean, which is of much smaller dimensions than either the Atlantic or Pacific, and is closed in by land on its northern side, is subject to more various influences, and does not exhibit any defined region of prevailing calm.

8. **The Trade-Winds.**—Within certain latitudes of the Pacific and Atlantic Oceans there prevail steady winds, blowing uniformly *from* the eastward—*i.e.*, towards the western quarters of the heavens. These are called, from their importance in connexion with the routes of maritime commerce, *trade-winds*. In the northern half of the globe, the trade-wind blows in general within the space included between the outer edge of the zone of calms and the parallel of 28° N. lat. : in the southern hemisphere, the parallel of 25° S. lat. marks its more general limit. But the range of these winds, like that of the zone of calms, undergoes some variation, oscillating within several degrees of latitude, farther to the north or south, according as the sun is north or south of the equator.

9. The trade-winds blow, in a general manner, *from east to west*. More strictly, the trade-wind of the northern hemisphere blows *from* the north-east—*i.e.*, it is a north-east wind: the trade-wind of the southern hemisphere blows *from* the south-east—that is, it is a south-east wind. These winds extend their influence not merely over the ocean, but over large portions of the adjacent land. In South America the trade-wind is felt up the valley of the Amazon to a distance of nearly a thousand miles inland.

10. The cause of the trade-winds is found in the greatly higher temperature of the air within and adjacent to the tropics, as compared with that in higher latitudes. The warm air of tropical regions is *lighter* than that of the regions lying nearer towards either pole; hence it has a tendency to rise, while the cooler and heavier air of temperate and polar latitudes presses in to take its place. The rotary movement of the earth modifies the direction of the atmospheric currents, in the manner already explained in reference to the currents of the ocean,¹ converting a movement along the meridian—*i.e.*, from north to south, or from south to north—into one which has (in the case of bodies of air advancing from regions of less rapid rotation to those of more rapid motion) a direction to the west of north. Thus, a current of air advancing from the direction of the north pole towards the equator becomes a north-east wind; while a current moving from the direction of the south pole becomes a south-east wind.

11. The warm ascending currents of intra-tropical air, moving respectively towards the poles of either hemisphere (to replace that set in motion towards the equatorial regions, and so preserve the general equilibrium), gradually lose their superior warmth and lightness, and afterwards descend to the surface, producing, in their conflict with the superficial currents of temperate latitudes, the prevailing westerly winds of either temperate zone.

¹ See page 41.

12. **The Monsoons.**—The monsoons are season-winds, blowing chiefly over the Indian Ocean and its adjacent lands. They, too, are trade-winds, like the currents of air last described; but, instead of being constant, they alternate in direction with the seasons—blowing for half the year from one quarter of the heavens, and for the remaining half from another quarter. The trade-wind of the Atlantic and Pacific Oceans is a perennial wind; the monsoon, or trade-wind of the Indian Ocean, is a periodical wind.

13. From October to March (i.e., during the winter of the northern hemisphere) a *north-east monsoon* blows over the northward half of the Indian Ocean, or from the neighbourhood of the equator to the shores of southern Asia, including the islands of the Malay Archipelago and the adjacent China Sea. From April to September, or during the summer months of those regions, the *south-west monsoon* blows within the same area.

14. Within a more southward portion of the Indian Ocean (including the coasts of north-western Australia and the coasts of eastern Africa to the south of the equator) a *south-east monsoon* blows between the months of April and September, inclusive—i.e., during the winter of the southern hemisphere. During the remainder of the year the wind in the neighbourhood of the Australian coast is a *north-west monsoon*; while that adjoining the African coast becomes a *north-east monsoon*.

15. It hence appears that the monsoon of the winter months, in either hemisphere, coincides in direction with the ordinary trade-wind of the Pacific and Atlantic Oceans; while during the opposite season of the year its direction becomes reversed. This is explained by the influence, during the summer months, of a vertical sun upon the coast-regions of the lands by which the Indian Ocean is closed in upon three sides—to the east, north, and west. The air, intensely heated by the solar rays during the period of summer, rises, owing to its superior light-

ness; and the cooler currents of air from the adjacent sea are set in motion towards the land, to take the place of the ascending currents.

16. The change of the monsoon does not occur suddenly, but is attended by violent thunderstorms, with irregular movements of the air. This constitutes the "break-up of the monsoon," after a few weeks of which the wind gradually settles round to the opposite quarter. The monsoons exert a most important influence upon the climate of India and other lands adjoining the Indian Ocean—one monsoon being accompanied by heavy rains, while that of the opposite season is a dry wind.

17. **Land and Sea Breezes.**—These are winds which blow alternately, about the hours of morning and evening, from the land on to the adjoining sea, or from the sea over the neighbouring land. They are experienced with most force in tropical lands, but prevail also in localities situated many degrees beyond the tropics, as on the shores of the Mediterranean, and other maritime regions lying within the warmer portions of the temperate zone. The land-breeze is the wind which, towards the early morning, blows *off* the shore; the sea-breeze sets in as the hours of evening draw near, and brings *to* the land a refreshing coolness from the adjacent waters.

18. Land and sea breezes illustrate, on a scale of diurnal change, the operation of the same laws which produce the monsoons within a period of annual change. They are due to the unequal heating of the air over adjacent land and sea, with the hours of day and night. During the hours of sunshine, the land acquires heat more rapidly than the adjacent water, and imparts this excess of heat to those portions of the atmosphere with which it is immediately in contact. The air over the land thus becomes hotter, and consequently lighter, than that over the adjacent water; and the difference becomes strongly marked during the hours of afternoon. The equilibrium of the whole *body of air* is hence disturbed. The lighter air over the land

has a tendency to rise; and the cooler air from above the water presses in to take its place. Hence the sea-breeze, which begins to be felt at (or shortly after) the time when the difference becomes most strongly marked—i.e., a few hours after mid-day, or toward the approach of evening. After sunset, on the other hand, the land rapidly parts with its heat, by radiation, while the temperature of the water remains nearly the same; towards the approach of early morning the land has become colder than the water; and the air over the water is relatively of higher temperature than that immediately above the land. Hence the former acquires a tendency to rise; and the cooler air from the adjoining shore sets seaward, to take its place.

19. The land and sea breezes are very conspicuous amongst the islands of the East and West Indies, on the shores of Guinea and Senegambia, and the coasts of Australia. Similar winds, alternating from opposite quarters of the heavens, are also felt in many inland districts, as in the valleys of the Amazon and its affluents.

20. Comparison of the map which exhibits the marine Currents with that which illustrates the Winds will show that the direction of both, within correspondent latitudes, is (in a general sense) the same; and the student will have observed that the explanation of both phenomena is, in great measure, identical. Difference in amount of solar heat, and consequent difference of density, combined with the axial rotation of the earth, are the prime causes which explain currents and perennial winds alike. The geographical distribution of both may be thus stated:—

- (1.) Within the warmer latitudes, the Winds, and also the oceanic Currents, have a general *direction to the westward*.¹

¹ Let the student bear in mind that a wind blowing *to* the westward is called an East wind; a current setting in the *same direction* is called a westerly current. The wind takes its distinguishing epithet from the quarter *whence* it blows; the current from the quarter *towards* which its course is directed.

- (2.) Within middle latitudes, the prevailing Winds, and also the principal oceanic Currents, have a *direction to the eastward*.
 - (3.) Within high latitudes, the prevailing direction of Winds and Currents alike is from the poles towards the equator—*i.e.*, from north to south in the northern hemisphere, and from south to north within the southern half of the globe.
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EXAMINATION QUESTIONS.

1. What is the *atmosphere*? Mention one of its properties. What amount of pressure does the air exert on the earth's surface?
2. What is the cause of *winds*? In what parts of the world are winds constant, or nearly so?
3. What is meant by the *calm latitudes*?
4. What are the *trade-winds*? Mark on the map the direction in which they blow.
5. Describe briefly the *monsoons*.
6. Give some account of *land and sea breezes*. To what causes are they due?
7. State, as a general summary, the prevailing direction of the winds (1) within the warmer latitudes, (2) within the middle latitudes, (3) within high latitudes.

X.

CLIMATE.

1. By the *climate* of a country is meant its comparative warmth, its greater or less abundance of rain, and the consequent moisture or dryness of its air, its prevailing winds and other phenomena of the atmosphere, and its consequent salubrity or insalubrity—*i.e.*, its suitability for the abode of man. The detailed study of such conditions belongs to the science of meteorology, but a statement of the general facts regarding climate belongs also to physical geography, and forms one of its most important chapters.

2. **Climate**, in so far as temperature is concerned, depends mainly upon the three following conditions :—

(1.) *Latitude*, or distance from the equator.

(2.) *Height above the sea-level.*

(3.) *Distance from the ocean.*

3. **Latitude** determines the angle at which the sun's rays reach the surface, in any particular region, and (according as the mid-day sun is more or less near the zenith) the consequent greater or less amount of direct solar heat which they impart. The countries within the torrid zone include the hottest parts of the globe, because they receive the rays of a vertical sun; those within the temperate zones receive less and less heat with successive distance from the tropics; and the frigid zones have received that epithet because of the still smaller amount of heat communicated by a sun which never attains more than a very moderate height above the horizon, while during portions of the year it is invisible during periods of more than twenty-four hours' duration.

4. *The respective length of days and nights* has a very important share in the determination of climate as regulated by latitude, and especially so in the case of countries within high latitudes. At the equator, day and night are of equal duration—i.e., of twelve hours' length; and in no part of the torrid zone is the excess *above* twelve hours at one season, or the period *short* of twelve hours at the opposite season, more than seventy minutes. Summer and winter are hence unknown within the tropics, range of temperature being confined within very moderate limits. In the temperate and frigid zones, on the contrary, the days at one season of the year, and the nights at an opposite season, are considerably above twelve hours in length, and the differences become greater with every degree of approach towards either pole. In the latitude of London ($51\frac{1}{2}^{\circ}$), the longest day is nearly seventeen hours, the shortest only seven hours. Under the Arctic and Antarctic circles, the longest day is twenty-four hours in duration, while at the winter solstice the sun remains below the horizon for a like period.

5. As long as the sun remains above the horizon, his rays communicate heat to the earth: during the period of darkness, the ground (by the process called radiation) keeps losing the heat which it had previously acquired. Long periods of continuous sunshine hence favour an accumulation of heat—long periods of darkness produce a contrary effect. The higher latitudes of the globe thus experience alternate extremes of heat and cold unknown within the regions that are within or near the tropics, and the summers and winters of such localities become more and more strongly marked by alternate intensities of temperature. During the long day of the polar summer, marked by a duration of *continuous* sunshine which has no parallel elsewhere, there is, for the time (in July and August), an excessive degree of heat; while the prolonged absence of the sun at the opposite season is accompanied by *the intense rigour* of an Arctic or Antarctic winter.

6. It hence follows, as to latitude, that—

- (1.) The *Torrid Zone* is a region of generally high temperature, nearly equal throughout the year.
- (2.) The *Temperate Zones* are regions of diminishing heat, on the average of the year; and with increasing range of seasonal temperature—or, in other words, the summers and winters become more strongly marked with increasing distance from the tropics.
- (3.) The *Frigid Zones* are regions of less temperature on the whole, with a winter of intense severity, contrasted with a brief season of high summer heat.

7. **Elevation.**—Increasing height above the general level of any region is accompanied by gradual decrease of temperature. The air is cooler at the summit of a hill than at its base, and the higher mountains are covered, at certain elevations, with unmelting snows. Plateaux or table-lands, whether of large or small extent, are of course influenced in a similar manner; their elevated surfaces are exposed to like cold influences as the mountain-top, though not always in precisely the same measure. The high plain of Quito (9,000 feet above the sea), the Mexican plateau (upwards of 7,000 feet), the plateau of Tibet (15,000 feet), and the plateau of Central Spain (2,000 feet), are examples of this. These and similar regions have a temperature which is many degrees colder than that of the low grounds in corresponding latitudes. Upon a small scale, the highlands of northern Scotland, and such regions as Dartmoor, in the south-west of England, supply like examples.

8. Elevated lands, such as the above, generally experience a brief period of high summer temperature, due to their exposure to the full force of the sun's rays at that season. This contrasts with a period of intense cold at the opposite season, when cold winds sweep over their high and exposed surfaces. Hence regions so circumstanced exhibit hot summers and severe winters. The summer heat of Madrid sometimes

reaches 110° in the shade, while its winter is excessively cold. Erzerum, Teheran, Ghiznee, and other Asiatic cities, lying on the high interior plateaux of that continent, supply examples of like extremes of temperature. Quito, on the other hand, though nearly on the line of the equator (and therefore in the very heart of the torrid zone), has a cool and very equable temperature—the latter condition being due to the sheltering influence of the high mountains which line on either side the elevated valley in which it stands.

9. **Distance from the sea** regulates climate in a very material degree, in consequence of the equalising influence of water on the temperature of the air. The extremes of heat and cold, at opposite seasons, are less in the case of islands than in continental regions; and, generally speaking, maritime regions have more equable temperatures than those lying far inland. The climate of the Polynesian Islands is more equable than that of any other part of the globe, the temperature not varying more than a few degrees throughout the year. Western Europe, bordering on the Atlantic, has a much more equable climate than the central and eastern parts of the same continent. The region of the steppes, in the east and south-east of the Russian plain, is distinguished by the conditions of intense summer heat and corresponding winter cold. The climates of Edinburgh and Moscow (cities in the same latitude) exhibit a striking difference due to this cause. At Edinburgh, the difference between the average temperature of the summer and winter quarters is less than 19° , while at Moscow it is nearly 49° .

10. **Continental and Insular Climates.**—Hence the wide difference which obtains between *continental* and *insular* climates—the former exhibiting extremes, the latter nearly equable in point of heat. Eastern Russia, Mongolia, Africa, and Central Australia, furnish examples of the former, as the Polynesian Islands, Madeira, Tasmania, and (in a less degree) Britain and New Zealand, do of the latter.

11. Minor causes affecting Climate.—The following are among the numerous minor conditions which affect climate, as concerns temperature:—

- (1.) **The direction of mountain-chains**, which may exert a sheltering influence, or the reverse, according as they lie to the north or south of any region. Thus, the Alps in some measure shut out Switzerland from the warm influences of the south, while, on the contrary, they protect Italy from the cold winds of the north.
- (2.) **The general slope of the land**, which is shown by the courses of the rivers in any country. This affects a large area of country in the same way that it does a tract of limited extent. A southern or western slope (within the northern hemisphere) is warmer than a northerly or an easterly one.
- (3.) **The nature of the soil**, and the extent to which it has been brought under culture. Gravelly and dry soils tend to raise the temperature; clayey and marshy soils, the reverse. The drainage of the ground, and the clearance of too-extensive forests, generally produce a favourable result upon climate. The destruction of forests may, however, in some cases produce a contrary result, as in the instance of Iceland, which has been rendered colder from this cause.
- (4.) **The direction of prevailing winds**, which are warm or cold, wet or dry, according to the regions they have traversed before reaching any particular district. In Britain, and in Europe in general, north and east winds are cold and dry, while south and west winds are warm and (especially those blowing from the south-west) often accompanied by moisture. This is an obvious consequence of the expanse of the Atlantic over which they have passed on their way to our shores.

- (5.) In the case of maritime countries, the **prevailing currents** of the adjacent ocean may have an important influence on climate, in virtue of the conditions stated in a preceding page.¹

12. **Local Winds.**—The names of the following *winds*, which occur in particular regions, deserve to be committed to memory :—

- (1.) **The simoom** is the hot wind of the African and Arabian desert. It raises the temperature like the blast of a furnace, producing a heat which is nearly insupportable, and filling the air with sand, which threatens to suffocate those exposed to its influence. In the deserts of Turkestan this wind is known as the *tebbad* (fever wind).
- (2.) **The sirocco**, which is experienced in the south of Europe, upon the shores of the Mediterranean, is the wind of the African desert, modified by its passage over the intervening waters. The *föhn*, or warm south wind of the Alps, has a similar origin.
- (3.) **The mistral**, a cold and dry wind which is experienced on the Mediterranean coast of France, has its origin in the mountain regions to the north-eastward, and blows down the valley of the Rhone.
- (4.) **The harmattan** is a cold and intensely dry wind, which blows from the north-east, during the months of December and January, upon the coasts of Senegambia and Guinea.
- (5.) **The hurricanes** of the West Indies, the *tornadoes* and *cyclones* of the Indian Ocean, and the *typhoons* of the China Sea, are rotary storms. They consist of a circular current of air moving with extreme velocity, like the vortex of a whirlpool, the entire current following at the same time an onward track, the path of which follows a curvilinear direction.

¹ See page 45.

Within the southern hemisphere, the rotary circle of wind follows the same direction as the hands of a watch (*i.e.*, west to north, east, and south); to the north of the equator it has an opposite course, as from west to south, east, and north.

13. **Isothermal Lines.**—A line drawn upon the map, or globe, through places that have the same temperature, is called an isothermal line.¹ Such a line may, of course, be drawn through places that coincide in point of mean annual temperature, or through places that have the same mean seasonal, or monthly, temperatures. The utility of isothermal lines consists in the fact that they render obvious to the eye the important truth that temperature depends upon many causes besides latitude. Places at correspondent distances from the equator often have widely different climates. The opposite shores of the North Atlantic Ocean present striking examples of this. The mean yearly temperature of Lisbon is nearly as high as that of Charleston (United States), though the latter place is six degrees nearer the equator. London has nearly the same mean annual temperature as Philadelphia, which lies eleven degrees nearer the equator. Edinburgh has a higher annual temperature than Halifax, in Nova Scotia, which is ten degrees nearer the tropic; and Copenhagen is warmer by several degrees than St. John's, Newfoundland, though the latter place is eight degrees to the southward of the former.

14. Isothermal lines are therefore very far from being coincident in direction with parallels of latitude. They deviate from the parallels to a much greater degree within the temperate and frigid zones than between or near the tropics; because the torrid zone is throughout a region of more nearly equable heat than other parts of the globe. When drawn upon the map of the world, the isotherms of mean annual temperature exhibit convex summits upon the western side of either

¹ Greek, *isos*, equal—*thermē*, heat.

continent—descending in the direction of the equator in their courses across the interior, and becoming concave in the neighbourhood of the eastern shores, of the Old and New Worlds alike.

15. Places that enjoy the same amount of *mean annual* heat may, however, experience very different *seasonal* temperatures. Thus, of two places, each with a mean annual temperature of 50° , one may exhibit a difference of only ten degrees between the averages of the summer and winter quarters; in the case of the other, the summer heat may attain an average of 90° , while the winter sinks to 10° . The climates of two places so circumstanced would obviously differ very widely. It is hence instructive to notice the course taken on the map by lines of mean summer and winter temperatures respectively.

16. In general, the western side of either continent, to the north of the equator, is warmer by several degrees than the eastern side, and is also more equable in temperature. In similar latitudes, the extremes of heat and cold, at opposite seasons of the year, exhibit a constant increase to the eastward, and become most marked on the eastern shores of the Old and New Worlds alike.

17. **Rain.**—The amount of rain-fall at any place is a highly important element in its climate. Rain is very unequally distributed over the globe. In some regions rain is almost constant, occurring at least within some portion of every twenty-four hours. In other regions rain only falls at intervals of several years. In many countries, again, the season of rain is limited to a few weeks annually, while during the remainder of the year the air is perfectly dry; in other lands the rains are distributed, more or less equally, through the whole year.

18. As general rules, the following laws hold good :—

- (1.) Rain is more abundant in warm than in cold countries,
—i.e., the amount of rain-fall diminishes from the equator towards the poles.

(2.) Rain is more abundant in maritime and insular tracts than in inland regions.

(3.) Rain is more abundant in hilly than in lowland regions.

2. Upon the whole, the quantity of rain that falls in the northern hemisphere is greater than in the eastern half of the globe. This naturally results from the fact that the extent of aquatic surface is much greater in the former than in the latter, since it is from the ocean that rain is originally derived, and the process of evaporation. Mountains and high grounds in general promote abundant rain-fall, by lowering the temperature of moist and warm currents of air—laden with moisture which are brought in contact with them by the winds.

3. **Dry and Rainy Seasons.**—There are fewer rainy days in the year in warm than in cold countries, although the quantity of rain is greater in the former. In tropical lands the year is divided into a wet and a dry season, and the rain-fall which occurs during the former period is prodigious in amount, a few hours of rain sufficing to cover whole tracts of country with water, and to convert every rivulet into a raging torrent.

1. Within the tropics the rains follow the course of the equator—the season of rain coinciding, upon either side of the equator, with the period of the sun's vertical place in the heavens. Thus, within the northern half of the torrid zone, the period between September and March is the dry season—the sun's place being then between the equator and the northern tropic; the rainy season falls within the opposite half of the year, when the sun is in north declination. In the southern hemisphere, the seasons of rain and drought are of course reversed.

2. Within the temperate zones, the period of greatest rain-fall generally occurs within the season of winter. But the respective seasons of rain and drought become less distinctly marked with increasing distance from the tropics.

3. The total amount of rain-fall within the year is greater in the torrid zone than in the temperate zones, and becomes

less with increasing distance from the tropics. But the number of days in the year upon which rain occurs is much greater within temperate regions.

24. The western hemisphere has generally a greater rain-fall than the eastern. The total amount of rain-fall within the tropical regions of the Old World is said to average 77 inches annually—that in the correspondent regions of the New World, 115 inches. In some tropical localities, the quantity of rain that falls within a few hours equals the rain-fall of the entire year within colder latitudes. The annual rain-fall of London is 24 inches ; that of countries lying south of the Alps, on the Mediterranean border, about 40 inches.

25. **Rainless Belt.**—A vast and nearly rainless region stretches through the continent of Asia and Africa. This region, which comprehends the vast expanse of the African Sahara, with the extensive deserts of interior Arabia, Persia, and Mongolia, is not, except in the worst portions of the Sahara, absolutely rainless ; yet rain only occurs at uncertain distant intervals, frequently of several years apart, and, consequently, it is distinguished by intense aridity. There are similar rainless, or almost rainless, districts in the New World, but of smaller extent. Some of the interior plains of the Mexican plateau are distinguished by intense aridity, though the maritime portions of that country exhibit an excessive rainfall. But the most remarkable of such tracts in the western half of the globe is found to the southward of the equator, embracing the coast-district of Peru and Bolivia, along the western base of the Andes, between those mountains and the Pacific Ocean. The tract known as the Desert of Atacamá falls within its limits. Throughout this extensive range of coast, it is only at rare intervals that a drop of rain refreshes the thirsty soil, the sole moisture being derived from dense mists (or *garuas*) which occur at certain seasons.

26. **Snow.**—When the temperature of the air is at, or below, the freezing point of fresh water, the particles of aqueous va-

pour are frozen into minute crystals, which unite and form snow-flakes. Snow is an admirable non-conductor of heat—thus effectually checking radiation, and protecting vegetation. In the tropics snow never falls, except at extreme elevations; in the temperate zones it falls on the lower grounds in winter only; within the polar circles it covers the land down to the sea level. The point above which the snow remains unmelted all the year round forms what is known as the *snow-line*, which rises from sea-level near the poles to about 16,000 feet under the equator. When a mass of snow accumulates on a steep slope, or on the edge of a precipice, large portions frequently break off, or sometimes the entire mass is suddenly precipitated into the valley below, overwhelming and destroying everything in its path. In tropical and temperate regions, *glaciers* occupy the higher recesses and valleys of nearly all the principal mountain regions, and descend far below the snow-line; in Polar lands, which are entirely covered with snow, they reach the sea-shore, and project into the water. By the action of the waves and currents, vast pieces are constantly broken off, forming the *icebergs* of the Polar seas.

27. *Glaciers*.—A glacier is an ice-stream, or river of ice, which has its origin in those portions of the mountain-region that lie above the snow-line, and moves slowly, but constantly, down the valley within which it lies. The glacier derives a constant supply (to replace the continual waste which goes on, owing to the thawing of the ice within its lower portion) from the snow which falls with each succeeding season, and most abundantly during the winter. At its lower extremity it is fronted by a mass of loose stone, rock, and various *débris*, derived from the mountain-side during its lengthened course, known as a *moraine*. Where the lower portion of the glacier has melted, the moraine is, of course, left standing, and marks the limit which the ice had once attained. The pressure of the accumulating mass of ice (or frozen snow) from above, and the downward-tending gravity of the whole, force the glacier

onward to a level which is far lower than that at which congelation would originate, until at length the warm temperature of the lower valley causes the ice-stream to melt, and stays its farther progress. The glacier then gives place to a stream of water, which issues from the lower extremity of the ice, and has already flowed beneath the surface, throughout great part of its lower course.

28. The surface of the glacier is *crevassed*—that is, intersected by deep rents, or crevasses, which are often many hundred feet in length, and of vast depth. These crevasses constitute one of the great difficulties in glacier-travelling. The rate at which the glacier moves is almost infinitely slow as compared with the motion of running water, owing to the partial rigidity of the ice which composes its mass. The average daily motion of the Mer de Glace (the glacier of Mont Blanc), has been ascertained to be about 17 inches in summer, but not more than $13\frac{1}{2}$ inches during winter. The aspect of the entire ice-stream undergoes frequent change, from the partial thawing (and consequent lowering of surface) which is occasioned by the heat of the summer sun.

29. There are glaciers in many other mountain-regions besides those above-mentioned. Glaciers of vast size occur among the Himalaya Mountains, and also in the chain of the Caucasus. A few of small size occur in the Pyrenees. In the Andes, where (from the fact of so large a portion of the mountain-region being within the tropics, and from its generally narrow proportions) the area of land under permanent snow is much less extensive than is the case with the great mountain-systems of the Old World, there are but few glaciers, and those generally of small size. The Rocky Mountains exhibit numerous glaciers—as, indeed, do all regions which include permanently snowed areas of any magnitude. The glaciers of New Zealand (within the South Island, and belonging to the chain of the Southern Alps) are of vast dimensions—surpassing those of the Swiss Alps. Greenland exhibits glaciers of stupendous

magnitude—the fertile source of the icebergs which are borne by currents along the waters of the western Atlantic, past the coasts of the North American continent.

EXAMINATION QUESTIONS.

1. To what three principal causes are differences of climate due ?
2. In what way do the differences in the respective lengths of day and night, at opposite seasons, affect the climate of places lying within the higher latitudes of the globe ?
3. What is the general character as to temperature of the torrid, temperate, and frigid zones respectively ?
4. In what way does height above the sea affect climate ?
5. What effect upon climate is generally produced by proximity to the sea ? Give some examples in illustration.
6. Distinguish between a *continental* and an *insular* climate.
7. What minor causes also tend to regulate climate ?
8. Describe briefly the nature of the following winds—simoom, sirocco, mistral, harmattan, hurricane, tornado, cyclone, typhoon.
9. What are isothermal lines ?
10. What three general laws serve to express the greater or less abundance of rainfall in particular localities ?
11. What are the seasons of rainfall within the torrid and temperate zones respectively ?
12. Explain briefly the terms snow-line, iceberg, glacier.

XI

AGENTS OF CHANGE

1. Attentive examination of the substances that compose the earth's crust (*i.e.*, of all that lies immediately beneath the surface-soil) shows that they possess great variety. Thus, granite, slate, marble of various kinds, sandstones, coal, chalk, clay, gravel, and sand, are found in different localities, and extending to various depths below the surface. All these substances are designated, in a geological sense, as rocks. Further examination, and comparison of one with another, has led to their division into two great classes, distinguished by the terms *aqueous* and *igneous*. The former have been deposited by the agency of water (Latin, *aqua*); and are found for the most part in regular layers, or *strata* (Latin, *stratum*); the latter are regarded as due to the agency of fire (Latin, *ignis*), and are often found protruded through the superincumbent masses, as though acted on by violent pressure from beneath.

2. Within the *aqueous*, *stratified*, or *sedimentary rocks*, there are found imbedded the fossilized remains of former life; and comparison of the fossils that are found in the various series of strata (chalk, sandstone, &c.) with one another, as well as with the living organisms of the present day, has enabled certain conclusions to be drawn as to their respective ages. Nearly every railway-cutting furnishes an example of rocks of this class.

3. The *igneous rocks*, on the other hand, contain no fossils, and sometimes display evidence of alteration in the original constitution of the mass, due to the agency of heat, or of heat and pressure combined. Granite may be taken as the most

typical specimen of this class of rocks, but the various forms of *trap* (basalt, &c.), together with the products of modern volcanic action, as lava, scorïæ, &c., come under the same general heading.

4. Like natural agencies to those employed in moulding the external surface of the globe to its present shape are still in operation, and are continually tending to produce changes in the respective areas of land and sea, in the aspect and comparative elevations of the land, and in the relative depths of the adjacent waters. Rivers are continually wearing down their beds, carrying the earthy particles which they hold in solution down to the sea, spreading the materials which once formed part of the solid ground over the floor of the ocean, in some cases filling up their channels of entrance from the sea, and converting into firm land what had once been deep water. Every little torrent that runs down the hill-side, and wears away its rocky or gravelly bed, contributes to this end. Atmospheric agencies tend to promote a like result; the moisture contained in the air gradually crumbles away even the hardest material exposed to it, and the surface of every mountain undergoes a constant waste from this cause—a waste which is greater in proportion to the moisture with which the air is laden.

5. Along the line of land and sea, again, there is continual conflict between the two: the base of the cliff often yields to the action of the water, and the masses of rock, undermined, fall into the adjacent sea. The water which, during rain, penetrates crevices in the earthy or rocky masses, promotes a like result, especially when it freezes, and, expanding in the process, sometimes rends off huge masses of cliff. Elsewhere the sea adds to the extent of solid ground, by the silting-up of estuaries, due to the influence of eddies and currents. Agencies of the description here glanced at have effected, and are still effecting, very considerable changes in the coast-line of Britain, especially along our eastern and southern

shores, as well as on the shores of Holland, Germany, and elsewhere.¹

6. **Igneous causes of Change.**—It is to the agency of subterranean heat, manifested in the *earthquake* and the *volcanic eruption*, that the more violent and striking changes in operation at the present day are principally due.

7. **Earthquakes.**—The earthquake is beyond doubt the most terrible of the natural dangers to which man is exposed; without any premonitory warning, the shock, which disturbs the solid ground over vast areas (giving it, in some cases, an undulating or waving motion; in others, causing an elevation, or else a sudden sinking of the land), may in a few seconds lay whole cities, with their inhabitants, in ruins. Though seldom of more than a few seconds' duration, the earthquake shock is often repeated, with longer or shorter intervals, during a prolonged period, which may extend over days, weeks, months, or even years. The number of earthquakes that occur annually, throughout the globe, is very great; above three thousand are known to have occurred within the first half of the present century, and upwards of three hundred are recorded within Europe alone during a term of ten years. Happily, however, by much the greater number are merely slight shocks, not more than one in forty being of such violence as to occasion any large amount of injury to man and his works.

8. **Volcanic Eruption.**—Volcanic eruptions may be regarded as manifesting, in another form, the same deep-seated influence of subterranean heat upon the earth's exterior. A *volcano*² is generally a mountain of conical shape, with truncated summit, and at or near its top a depression, called (from its shape) a *crater*.³ From this crater, when the mountain is in eruption, issue volumes of dense vapour, combined with various gases,

¹ See, for particular examples, the advanced "Class-Book of Physical Geography." (George Philip & Son).

² From the Latin, *Vulcanus*, the god of fire.

³ Latin, *crater*, a cup.

followed in most cases by intensely-heated sand, stones, masses of rock, or other *scoriæ* ; accompanied, in the case of some volcanoes, by a liquid substance called *lava*, which flows over the edge of the crater, and rolls slowly down the mountain-side. Some volcanoes are, for a lengthened period, in frequent (or nearly continual) eruption ; in other instances the subterranean fires remain dormant during a lengthened period, and the eruption is only renewed at intervals of many years' duration. Vesuvius, near the city of Naples, in the south of Italy one of the most famous of the European volcanoes, first showed itself in eruption, 79 A.D., when the ashes which it ejected completely overwhelmed and buried the neighbouring cities of Pompeii and Herculaneum. Since that period its eruptions have been frequent, though with some long periods of intermission. In some countries there are extinct volcanoes, the fires of which have been long burnt out, and in many regions where no active volcanic force now exists, there are found over large areas rocks which must have been the product of former volcanic fires.

9. Geographical Areas.—The regions in which active volcanoes occur are the same as those within which shocks of earthquake are experienced. They are found, with hardly an exception, in near proximity to the sea, either upon peninsulas and islands (as is generally the case in the eastern half of the globe), or within the mountain-chains and highlands which border the Pacific coast of the continent, in the western hemisphere. Three great volcanic circuits, in connexion respectively with the basins of the Pacific, Indian, and Atlantic Oceans, are capable of being marked out upon the map.

10. Volcanic Circuit of the Pacific.—Along the whole western side of the New World, from Tierra del Fuego to the peninsula of Alaska and the neighbouring Aleutian Islands, earthquakes are of occasional occurrence, and active volcanoes are found at intervals. The latter are especially numerous within portions of the Andes, and are also common in the

highlands of Central America, and upon the Mexican plateau. Several of the highest volcanoes in the world are found in the neighbourhood of Quito, nearly under the equator.

11. Upon the western side of the Pacific basin, Kamtschatka, the Kurile Islands, Japan, and the entire region of the Malay archipelago, display similar conditions. The prolongation of the volcanic chain to the southward of the Philippine and Moluccas groups is seen in the New Hebrides, again in New Zealand, and, much farther south, in the distant land known as South Victoria, where Mount Erebus is found discharging its fires within a few degrees of the southern pole. The detached volcanoes of the Sandwich, Friendly, Society, and Marquesas groups, belong to the same region.

12. **Volcanic Circuit of the Indian Ocean.**—Active volcanoes are numerous throughout the great island region which intervenes between the Pacific and Indian waters, and nowhere more so than in Java, where they range in a direct line from the eastern to the western extremity of the island. The volcanic chain of Java is prolonged to the eastward through the Lesser Sunda Islands (Sumbawa, &c.), in which direction it is united with that which borders upon the Pacific. Barren Island, in the Bay of Bengal, exhibits an extension of the chain to the northward. The Red Sea exhibits the same conditions upon some of the islands within its basin, as well as on its western shores. The island of Mayotta (Comoro group), Réunion or Bourbon Island, and the hot springs of St. Paul and Amsterdam, in high southern latitudes, are points which indicate the continuity of the volcanic chain, while earthquakes (often of great violence) are experienced within the lands that border the Indian Ocean to the northward.

13. **Volcanic Circuit of the Atlantic.**—The south-west portions of Asia, the south parts of the European continent and its adjacent islands, with the north-west parts of Africa, fall within this region upon one side, as the islands of the *West Indies* do upon the other. The circuit of the Mediter-

anean (around nearly the whole of which earthquakes are experienced) is included within its limits. To the northward, the numerous volcanoes of Iceland, and the more distant cone of Jan Mayen Island, fall within the Atlantic area, together with the volcanic peaks of the Azores, the Cape Verd, and Canary groups. In the opposite direction, the Cameroons mountain, adjoining the upper extremity of the Gulf of Guinea, is an outlying member of the same region.

14. Active Volcanoes.—More than 300 active volcanoes are known. A few of the more important, within either hemisphere, are included in the following list:—

WESTERN HEMISPHERE.		EASTERN HEMISPHERE.	
	<i>Feet.</i>		<i>Feet.</i>
Gualatieri (Andes).....	21,960	Kliuchevsk (Kamtschatka) ..	16,512
Arequipa (do.)	20,320	Cameroons, Peak of (West	
Antisana (do.)	19,187	Africa)	13,129
Cotopaxi (do.)	18,877	Slamat (Java)	12,300
Tolima (do.)	18,028	Indrapura (Sumatra)	12,140
Popocatepetl (Mexico)	17,773	Tomboro (Sumbawa Island) ..	7,600
Orizaba (do.)	17,373	Teneriffe (Canary Islands) ..	12,236
Tunguragua (Andes)	16,579	Fusi (Nippon: Japan)	12,000
Tolima (Mexico)	15,271	Etna (Sicily)	10,874
Mauna Loa (Sandwich		Piton de la Fournaise	
Islands)	14,000	(Réunion)	7,200
Erebus (South Victoria)	12,400	Beerenberg (Jan Mayen	
Cosiguina (Central America) 1,000		Island)	6,870
		Hekla (Iceland)	5,096
		Vesuvius (Italy)	3,932

15. Coral Islands exhibit another form of change, of altogether distinct nature to the above, but in virtue of which a continual addition is making, within certain regions of the globe, to the area of habitable land. They are due to the labours of the coral-worm, which, basing its labours upon submarine reefs, lying at a moderate depth (probably seldom more than twenty or thirty fathoms), keeps building upwards towards the surface, continually adding to the extent of the hard stony secretion in the interstices of which it dwells. When the surface is once reached, its labours in a vertical direction cease, but the lateral extent of the reef continues to increase, and with most rapidity in the direction most exposed to the force

of wind and sea, i.e., upon the windward side of the reef or island. A vast number of the Pacific Islands, as well as the Maldivé and Chagos groups in the Indian Ocean, with the Bahama Islands, and the little group of the Bermudas in the Atlantic, are of coral formation. The Bermudas, which are in $32^{\circ} 20'$ N. lat., are farther distant from the equator than any other coral reefs; since the coral-worm requires a high temperature, coral is only found, tenanted by its living architects, within tropical or sub-tropical seas.

EXAMINATION QUESTIONS.

1. Into what two great classes are the various substances that compose the earth's crust divided?
2. In what kind of rocks are *fossils* found?
3. What are the chief "agents of change?" Give some examples of changes produced by the action of rivers or the sea.
4. In what form is *igneous* action chiefly manifested?
5. What is an *earthquake*?
6. Explain the terms *volcano*, *crater*, *scoria*, *lava*. Distinguish between *active* and *extinct* volcanoes, and give some examples of each.
7. Trace on the map the volcanic circuit of the Pacific, Indian, and Atlantic Oceans respectively.
8. Give the names and elevations of a few of the principal *active* volcanoes in either hemisphere.
9. What are *coral* islands?

XII

NATURAL PRODUCTIONS OF THE EARTH—
MINERALS.

1. Coal takes the first place in order of importance to man amongst the productions of the mineral kingdom. It is, happily, of exceedingly wide distribution, the beds in which it occurs, in workable condition, being found in widely-distant regions of the globe. They are nowhere worked to so abundant an extent as in Great Britain, the annual coal-produce of which is about one-half of the total produce of the globe—i.e., the quantity of coal furnished by the mines of Britain is equal to that of all other coal-mines in the world taken together !

2. Coal is known to exist in the following regions :—

- (1.) *Europe*.—Great Britain and Ireland, Belgium, France, Germany, Hungary, Spain, Russia, Sweden.
- (2.) *Asia*.—India, China, Japan, Persia, Syria, Asia Minor, Burmah, Malay archipelago (Labuan Island).
- (3.) *Africa*.—Valley of the Zambesi, Natal.
- (4.) *America*.—United States, New Brunswick, Cape Breton I., Prince Edward I., Vancouver I., Greenland, Cuba, Chili.
- (5.) *Australia*.—New South Wales, Queensland, Victoria, Tasmania, New Zealand.

3. The total area of the British coal-fields is about 2,780 square miles, and the annual output upwards of 130,000,000 tons, of which about 15,000,000 tons are exported. Belgium, the coal-fields of which are about 520 square miles, supplies about 14,000,000 tons per annum. The coal-fields of the United States have an area of about 196,800 square miles, above seventy-fold that of the British coal-fields ; and although they are at present only worked to a limited extent, compared with their vast capabilities, the annual produce

is upwards of 50,000,000 tons. They fall principally within the states of Pennsylvania, Ohio, Western Virginia, Illinois, Michigan, and Missouri.

4. Iron is even more widely distributed than coal. There are few countries in which iron does not enter, in one form or other, into the mineral composition of rocks. In Britain, the carboniferous beds are the seat of the most extensive iron produce; but iron is by no means confined to those localities. The quantity of pig-iron furnished annually by Great Britain exceeds 6,000,000 tons. In the United States the total product of iron in 1880-1 was 8,000,000 tons.

5. The principal countries in which iron is found are:—

- (1.) *Europe*.—Great Britain and Ireland, Belgium, France, Russia, Germany, Sweden and Norway, Italy, Spain.
- (2.) *Asia*.—Asia Minor, Georgia, Armenia, Persia, India, Siberia, Japan, Malay archipelago.
- (3.) *Africa*.—Algeria and Atlas region in general, Zambesi valley, South Africa.
- (4.) *America*.—United States, Canada, New Brunswick, Nova Scotia, Cape Breton L., Brazil, New Granada, Bolivia, Chili, La Plata.
- (5.) *Australia, &c.*—New South Wales, Victoria, Tasmania, New Zealand.

6. Copper is worked to a large extent in Britain (chiefly Devon and Cornwall), but is supplied in larger quantity by Chili, Cuba, and South Australia. The countries in which it chiefly occurs are—

- (1.) *Europe*.—British Islands, Spain, Russia, Hungary, Sweden and Norway, Turkey, Germany.
- (2.) *Asia*.—Asia Minor, Armenia, Siberia, India, China, Japan, Persia, Malay archipelago.
- (3.) *Africa*.—Algeria, Zambesi valley, South Africa.
- (4.) *America*.—Canada, Rupert Land, Cuba, Chili, Peru, Bolivia.
- (5.) *Australia, &c.*—South Australia, New Zealand.

7. **Tin**, a valuable and rare metal, is derived chiefly from the mines of Cornwall, and from the island of Banca (lying east of Sumatra), in the Malay archipelago. It occurs also in Spain (province of Galicia), and Bohemia; likewise in Burmah, Assam, the Malay peninsula, and some of the other islands of that region; also in California, Mexico, Peru, Chili; and within recent years in New South Wales, Victoria, Queensland, Tasmania, and New Zealand.

8. **Lead** occurs most abundantly in the following countries:—

(1.) *Europe*.—Spain, Great Britain and Ireland, Germany (Carinthia, Bohemia, &c.); Hungary, Transylvania, France, Belgium, Norway, Portugal, Turkey. The mines of Carinthia are of very high value.

(2.) *Asia*.—Siberia, Armenia, India, China, Siam, and Japan.

(3.) *Africa*.—Atlas region (Algeria).

(4.) *America*.—United States, Canada, Chili, Peru, Bolivia, La Plata.

(5.) *Australia*.—South Australia, Western Australia.

9. **Zinc** is derived chiefly from England and Wales, Prussia, and other parts of Germany, Belgium, Spain, the United States, China, and Australia (Victoria).

10. **Quicksilver**, or mercury, is a metal of limited distribution. The most valuable sources of supply are the mines of Idria (in Carniola, a province of Austrian Germany), and those of Almaden, in Spain (La Mancha), within the Old World. China and Japan also furnish this metal. In the New World, Peru and California are the chief regions where quicksilver is derived.

11. **Gold**.—The discoveries of recent years have shown that this metal is of much more extensive distribution than was formerly supposed. The gold-fields of California (discovered in 1848) and those of Australia (first worked in 1851) have far surpassed any others in richness of produce, and have together applied upwards of £20,000,000 sterling annually—a vastly greater quantity than that derived from all other regions.

united. The Siberian gold-mines come next in amount of annual produce. The New Zealand gold-fields are also of high value, the exports up to the present time amounting to nearly 10,000,000 oz.

12. The principal sources of supply for gold are :—

- (1.) *Europe*.—Transylvania, Hungary, Italy, Spain, Wales, Ireland (Wicklow Mountains).
- (2.) *Asia*.—Siberia, Tibet, China, Burmah, Siam, Malay peninsula and archipelago (Borneo, &c.), Cochin-China, Tonquin, Japan.
- (3.) *Africa*.—East and West coasts, within the tropics; interior Soudan; Transvaal.
- (4.) *America*.—United States (California), British Columbia, Mexico, Central America, Brazil, New Granada, Bolivia, Chili, La Plata.
- (5.) *Australia, &c.*—Victoria, New South Wales, Queensland, Tasmania, New Zealand.

13. **Silver** is supplied, in a native state, chiefly by the following countries :—

- (1.) *Europe*.—Hungary, Transylvania, Germany (Bohemia, Saxony, Hanover, &c.), Turkey, Norway, Spain, England.
- (2.) *Asia*.—Siberia, China.
- (3.) *America*.—Peru, Mexico, Bolivia, New Granada, Chili, La Plata.

14. Of other less important minerals, the principal are :—

- (1.) **Bismuth** (employed chiefly as an alloy, in making pewter, &c.), which is derived chiefly from Saxony; also found in Siberia, Cornwall, and South Australia.
- (2.) **Antimony** (of like usage, especially in the manufacture of type-metal), supplied chiefly by France and Hungary; also Spain, Britain, and the province of Sarawak, in the island of Borneo. It is also found in New South Wales, Victoria, Queensland, Tasmania, and New Zealand.

- (3.) **Manganese**, worked in Devon and Cornwall; also Germany, Hungary, France, New South Wales, and Victoria.
 - (4.) **Nickel**, worked in Germany (Saxony, Bohemia, &c.), France, and Cornwall.
 - (5.) **Cobalt**, derived from various ores, found in Spain, France, various parts of Germany (Saxony, &c.), and Cornwall.
 - (6.) **Arsenic**, derived chiefly from Germany (Saxony, and the Harz regions), Hungary, Transylvania, Siberia, France, Cornwall, and New South Wales.
 - (7.) **Sulphur**, a combustible mineral, is derived chiefly from Sicily; it also occurs abundantly in Spain, and is found in the volcanic districts of New Zealand.
 - (8.) **Graphite**, or **plumbago**, (erroneously called black-lead) occurs in Siberia, Norway, and other countries, but is chiefly derived from the high valley of Borrowdale, in the mountain district of Cumberland. Valuable deposits have been found near Wellington, in New Zealand.
15. The **diamond** is, in the present day, found chiefly in Brazil, and in South Africa (Griqualand West); also, though to a much smaller extent, in India, Borneo, and the Ural mountains.
16. Of other precious stones—
- (1) The **emerald** is derived chiefly from Peru, and the neighbouring parts of South America.
 - (2) The **ruby**, from Burmah, Ceylon, and Turkestan.
 - (3) The **amethyst** and **topaz**, from Ceylon and China.
 - (4) The **turquoise**, **amethyst**, **jasper**, **topaz**, **cornelian**, and several others of less value, from India, Turkestan, Tibet, Siberia, also the mountain districts of Russia, Hungary, Transylvania, &c.
17. **Salt** occurs, as a solid mineral, over vast areas of the globe, besides its presence in a state of solution throughout

the vast ocean, as well as in many inland seas and lakes. Portions of the steppe region, in the south-east of Europe, the tract known as the Great Salt Desert (Persia), and large areas in the western half of the African Sahara, exhibit inexhaustible quantities of this mineral. In Britain the chief supply of salt is derived from Cheshire and Worcestershire, within the area of the formation known to geologists as the new red sand stone, the finest description being the produce of brine-springs. The salt mines of Bochnia and Wielicza, in Austrian Poland or Galicia (east of Cracow), are worked on a vast scale. Upon the coasts of Spain, Portugal, southern France, and other warm regions, as well as, to a very much smaller extent, upon parts of the English shores, salt is obtained by evaporation from the sea-water, admitted for the purpose into shallow excavations or salines.

EXAMINATION QUESTIONS.

1. In what parts of the world is *coal* known to exist? What proportion does the coal produce of Great Britain bear to that of other countries?
2. Point on the map to the principal *coal-fields* of Great Britain and the United States.
3. In what countries is *iron* principally worked?
4. From what countries is *copper* chiefly derived?
5. What parts of the world include the principal *tin* and *lead* mines?
6. Whence is *zinc* and *quicksilver* chiefly obtained?
7. Point out on a Map of the World the localities of the principal *gold-fields*.
8. What countries furnish the chief supply of *silver*?
9. From what countries are the following chiefly derived :—*Bismuth, antimony, manganese, nickel, cobalt, arsenic, sulphur, and graphite*?
10. In what countries are the *diamond, emerald, ruby, turquoise, and amethyst* chiefly found?
11. Indicate on the map some of the principal localities of *salt*.

XIII

NATURAL PRODUCTIONS OF THE
EARTH—PLANTS.

1. The geographical distribution of vegetable life is in great measure regulated by conditions of soil and climate. The great essentials to the growth of plants are *light, heat, and moisture*, and the various proportions in which these are combined, in the instance of any particular locality, determine its suitability for the development of any particular description of tree, fruit, flower, vegetable, or plant of any kind. Speaking generally, vegetation is most luxuriant within tropical regions (under the combined influence of heat and moisture), and diminishes in variety and abundance with increasing distance from the equator. The increasing inequality in the lengths of successive periods of light and darkness, which is proper to high latitudes, and which becomes greatest within the polar circles, is accompanied by obvious peculiarities in the classes of plants that are native to such regions.

2. *Elevation*, as well as *latitude*, affects the growth of plants. In this respect a high mountain within the torrid zone supplies an example of the conditions that belong to an entire hemisphere. The luxuriant vegetation of the tropics, which flourishes around its base and for a moderate distance up, gradually gives place to hardier forms of life. These become dwarfed as the cold region of the mountain-top is approached, and at length only creeping plants, such as mosses and lichens, are found, while all sign of vegetation disappears with the presence of perennial snow.¹

¹ See page 69.

3. **Zones of Vegetable Life.**—In so far as influences of climate are concerned, a division of the earth's surface into the following zones serves to express some important truths:—

- (1.) A zone of *Palms and Bananas* (Equatorial), with various Spices. This zone stretches from the equator to about 15° upon either side.
- (2.) A zone of *Tree-ferns and Figs* (Tropical), Sugar-cane, Coffee, Cocoa, &c. ; reaching from about lat. 15° to 25° within the northern, and 15° to 23° within the southern, hemispheres.
- (3.) A zone of *Myrtles and Laurels* (Sub-tropical), with Fig, Olive, Vine, Orange, and, in Asia, the Tea-plant; it ranges between 25° and 35° N., between 23° and 30° S. latitude.
- (4.) A zone of *Evergreens* in general (Warm Temperate), with Vine, Maize, Cotton, Indigo, &c. ; ranging between 35° and 45° in Europe and Western Asia ; in the New World, and also in Eastern Asia, scarcely reaching so far north as 40° ; to the S. of the equator, between 30° and 40° .
- (5.) A zone of *Deciduous Trees*,¹ (Cold Temperate), with Wheat and other cereals, also Hemp and Flax ; ranging between 45° and 55° over the chief part of the northern hemisphere ; within the southern hemisphere, from 40° southward.
- (6.) A zone of *Conifers*² and *Edible Berries* (Sub-Arctic), with the hardier grains, as Barley and Oats. It ranges between the parallels of 55° and 66° within Western Europe, and nearly as high on the west side of North America ; elsewhere descending to between 45° and 55° . The extremity of South America falls, on the opposite side of the globe, within this zone.

¹ Deciduous plants are those that cast their leaves annually. Latin *decidere*, to fall.

² Some of the pine and fir tribe, from the conical form of their fruit, of which the common fir-apple is an example.

(7.) A zone of *Lichens, Saxifrages, and Dwarf Shrubs* (Arctic), ranging between 66° and 72° upon the western side of either continent; over the greater portion of both Old and New Worlds, between 55° and 60°.

(8.) A zone of *Mosses and Alpine Plants* (Polar), reaching from the last-named limits in the direction of the pole.

4. **Botanical Regions.**—It is, nevertheless, a well-known fact that each region of the earth has plants peculiar to itself, and that portions of either hemisphere which correspond in the general conditions of climate are distinguished by widely different forms of vegetation. Whole families of plants which are native to certain countries in the northern half of the globe are absent from the correspondent latitudes on the south of the equator, where totally distinct forms take their place; and like differences obtain between the plants that are native to the Old and New Worlds respectively. Even where the same families (*genera*) are represented, the particular kinds (*species*) are nearly always different. In other words, each portion of the globe has its own distinct *flora*, and certain well-defined botanical regions, each distinguished by typical forms of vegetable growth, can be marked out upon the map of the world.

5. **The food plants** in most extensive usage supply examples of the above truth. *Wheat, barley, rye, oats, and rice*, are native only to the Old World, though they have all been transplanted by man to the countries on the west of the Atlantic, and are now extensively grown in America, as well as (with the exception of rice) in Australia, where they were similarly wanting. *Maize*, on the other hand, is native only to America, though now grown in many parts of Europe and Asia.

6. The *potato*—now of perhaps wider distribution than any other food-plant—is a native of the New World, and was unknown to the people of other lands until the middle of the

sixteenth century. The same is true of the *tobacco-plant*, which has become diffused over the greater part of the globe. The *mandioc*, or cassava-plant, which supplies the principal food of the South American Indians, is another of the indigenous productions of the New World, wanting in other lands. The family of trees known as *cinchona*, from which quinine is derived, is naturally confined to South America, but was some years ago transplanted to southern Asia.

7. The *tea-plant*, native only to south-eastern Asia, is another example. The *coffee-shrub* was originally limited to the tropical belt of the Old World. The *cacao* (or cocoa) tree belongs only to the correspondent portions of the American continent. The *bread-fruit tree* is the characteristic produce of the islands of the Pacific (Polynesia). The *date-palm* belongs to the warm belt of the Old World—chiefly to the heated plains of south-western Asia, and the northern half of the African continent—the *cocoa-nut palm* to the western coasts and islands of southern Asia, and the adjacent region of the Malay archipelago.

8. **Changes effected by Human Agency.**—The distribution of plants undergoes great changes at the hands of Man, who carries with him in his migrations the germs of whatever can be profitably cultivated in his new home, and derives from other regions whatever productions are likely to flourish under the conditions of soil and climate that distinguish his native land. It is thus that the wheat and other cereals, with numerous fruits, of the Old World have been exchanged for the maize, potato, tobacco, and cinchonas of the New. And in like manner the grains and fruits of southern and western Europe have been carried to Australia, and found to thrive in a region which has fewer food-plants of its own than any other division of the earth.

9. **The geographical distribution of the principal food-plants.** with a few others that are of high value to mankind, is stated in the following table :—

- (1) **Wheat, Barley, Rye, and Oats** are natives of the Old World, and all but the last named were probably derived originally from western Asia. All of them are now cultivated within those portions of the New World that possess a suitable soil and climate. Wheat is also in very extensive culture in Australia.
- (2) **Rice** is also a native of the Old World, and is the chief food-plant of southern Asia. It has long been extensively cultivated in parts of the North American continent.
- (3) **Millet** (of which there are several species—some of them extensively used as food) is native to the Old World. The best known kind is the *dhourra* of Egypt (Nubia). It has been introduced into the West Indies, where it is known as guinea-corn.
- (4) **Maize**, or Indian corn, is the chief native food-plant of North America. It is now largely cultivated in the countries of central and eastern Europe, and also in parts of Australia and Africa.
- (5) **Cassava**, or **Mandioca**, is prepared from the root of the *jatropha manihot*, a plant which is indigenous to Brazil, Guiana, and the neighbouring part of South America, whence it extends into the Mexican isthmus. Tapioca is a kind of starch prepared from the same root.
- (6) The **Potato** is native to both divisions of the American continent, whence it has become distributed over nearly the whole globe. Within the tropics, however, it requires a considerable altitude to neutralise the effects of too great heat.
- (7) The **Yam** is a native of the Old World—most abundantly found within southern and south-eastern Asia. It has become extensively introduced into the West Indies.

- (8) The **Arum**, or taro, a native of the Polynesian group, from the Sandwich Islands to New Zealand. The **Batata**, or sweet-potato, belongs to the same region.
- (9) **Arrow-root**, which is prepared from the root of a herbaceous plant, is a native of South America, whence it has been transplanted to the West Indies, the Bermuda group, and parts of southern Asia, and South Africa.
- (10) The **Banana** and **Plantain**, varieties of the same plant, are native to the tropical regions of the New World, flourishing throughout a zone (of either hemisphere) within which the mean annual temperature is not lower than 75° . The banana also forms the "staff of life" to the coloured natives of Eastern Africa.
- (11) The **Bread-fruit tree** is a native of the islands of the Pacific Ocean, within warm latitudes, and has been transplanted thence to the West Indies. Its fruit supplies the chief article of food to the natives of Polynesia.
- (12) The **Cocoa-nut palm**—one of the most valuable of the numerous trees belonging to the palm tribe—is native to the warm and watered regions of both hemispheres. It abounds especially upon the islands and maritime regions of southern Asia, and throughout the Polynesian Islands.
- (13) The **Date-palm** is indigenous to the warm and arid regions of the Old World, its range extending from the region of the Atlas to the plains of India. Dates are extensively used as food by all the nations of northern Africa and the south-western parts of the Asiatic continent. The date-palm flourishes in Sicily, and on the rock of Malta.

- (14) The **Sago-palm** is a native of south-eastern Asia, and is especially abundant in Celebes, the Moluccas, and adjacent islands. The pith of this tree constitutes the sago of commerce.
- (15) The **Pandanus**, or **Screw-palm**, which yields a juicy aromatic fruit, is a native of the Caroline Islands (Polynesia).
- (16) The **Tea-plant** is indigenous to China, Tonquin, Cochin-China, and Japan. Its range within the first-named country (whence nearly all the tea of commerce is derived) is restricted to the south-eastern provinces, between the parallels of 23° and 31°, embracing Fo-kien, Kiang-su, and Che-kiang. It is also successfully cultivated in British India (Assam).
- (17) The **Coffee-plant** is a native of Abyssinia, whence it became early naturalised in south-western Arabia (Yemen). It has been introduced into the New World, from parts of which (Cuba, Brazil, Guiana, and Central America) coffee is now largely derived.
- (18) The **Cacao-tree** (cocoa and chocolate of commerce) is a native of South America, the region of the Amazon being its principal seat. It is also grown in Central America, Mexico, and the West Indies.
- (19) The **Sugar-cane** is a native of China, Cochin-China, and the adjacent parts of south-eastern Asia, whence it has been carried to the New World, where, however, the same plant appears to exist in a wild state.
- (20) The **Cotton-plant**, of which there are several species, is indigenous to southern Asia and Africa, as well as to the New World, where it has been more largely grown than in any other region. It has been introduced with success into Eastern Australia (New South Wales and Queensland).

- (21) **Flax** (the stem of which furnishes the fibre known by that name) is a native of the temperate regions of the Old World. *Hemp* belongs to the same, or nearly the same, localities. The New Zealand flax, which furnishes the fibre from its long, sword-like leaves, grows only in the temperate regions of the southern hemisphere.
- (22) **Indigo**, of which there are several species, is found growing wild in many parts of Asia and Africa, as well as within the warm latitudes of the New World.
- (23) The **Cinnamon-tree**, the bark of which constitutes the cinnamon of commerce, is indigenous only to Ceylon. Other trees belonging to the same genus, but of different species to the true cinnamon, occur in parts of south-eastern Asia and the islands of the Malay archipelago.
- (24) The **Clove** is a native of the Molucca Islands, and peculiar to that region. Its culture has been introduced into the island of Réunion or Bourbon.
- (25) The **Nutmeg-tree** is also indigenous to the Moluccas, but is found in several other parts of the East Indies (Sumatra, &c.) It has been introduced into the Mauritius. The nutmeg of commerce is the kernel contained within the fruit of this tree; the spice known as *mace* is the membranous covering which immediately encloses the kernel.
- (26) **Ginger** is a native of south-eastern Asia and the adjacent islands. It was early introduced by the Spaniards into the New World, and is probably indigenous also to that side of the globe. It is extensively cultivated in Jamaica and other parts of the West Indies. The tuberous root of the plant supplies the ginger of commerce.
- (27) **Pepper**, of which there are numerous species, is found in every quarter of the globe, excepting Europe.

Both black and white pepper are the produce of the *piper nigrum* of botanists—a perennial plant, found native in India and the Indo-Chinese peninsula, and especially abundant on the Malabar coast. It is largely cultivated in Sumatra, Java, and the neighbouring islands.

- (28) **Pimento**—the allspice of commerce—is supplied by the berries of a tree (*myrtus pimenta*) native to South America and the West Indies, and extensively cultivated in Jamaica.

EXAMINATION QUESTIONS.

1. What conditions chiefly regulate the geographical distribution of plants?
2. Into what zones of vegetable life may the surface of the globe be divided?
3. In what way does elevation affect the growth of plants?
4. Are the same plants found in regions having similar climates?
5. Name a few instances amongst food-plants of differences between the indigenous flora of the Old and New Worlds.
6. What changes in the distribution of plants have been effected by human agency?
7. To what regions are the following indigenous—*wheat, barley, rye, oats, rice, and maize*?
8. From what plant is *tapioca* prepared?
9. Name the native regions of each of the following—*potato, yam, taro plant, sugar-cane, coffee, and tea plant*.
10. To what regions are the *banana, bread-fruit, cocoanut, date-palm, and sago-palm* respectively native?
11. Whence are the following derived—*cotton, indigo, madder, cochineal, cinnamon, clove, nutmeg, ginger, pepper, and allspice*?

XIV.

GEOGRAPHICAL DISTRIBUTION OF ANIMALS.

1. Every great region of the earth has its peculiar forms of animal life, alike in the case of land animals and the tenants of the air or the water. The quadrupeds, birds, reptiles, and insects that are native to the Old World differ from those that are native to the American continent; and those that are found in a native state within the northern hemisphere are generally absent from the corresponding latitudes to the south of the equator. Australia—the only one of the continents that is wholly within the southern half of the globe, and is cut off by surrounding seas from contact with other lands—has a zoology which is wholly unlike that of any other part of the globe.

2. Striking examples of this truth are supplied by well known and popular instances in the case of the domestic animals. The horse, ass, ox, and common sheep, were all unknown in America until after the time of Columbus, when they were carried across the Atlantic by the Spaniards; and a century has not yet elapsed since the same animals were first introduced into Australia. The elephant, hippopotamus, and rhinoceros, the camel, antelope, and giraffe, the lion, tiger, leopard, panther, and hyena, are natives only of the Old World. On the other hand, the puma and jaguar (the lion and tiger of the New World) are confined to the forests of tropical America; and the kangaroo is only found within the Australian wilderness.

3. Like differences exist in the case of birds, reptiles, insects, and indeed in all the forms of animal life. The bird of *paradise*, the gold and silver pheasants, and the peacock, are con-

ined to the eastern hemisphere ; the true humming-birds are found only in the western half of the globe. The brilliantly-plumaged parrots and cockatoos of either hemisphere are distinct from one another in species (and, in most cases, in genus) ; and the vulture of the Old World is replaced by the condor of the New.

4. These differences are independent of mere climate. The animals of distant lands, carried by man from one region to another, are found in numberless instances to thrive equally in their new home as within the range of their native pastures. The course of exchange between the native life of the Old and New Worlds has been in progress ever since the days of early Spanish settlement beyond the Atlantic. Horses and oxen are now reared in vast abundance in the plains of South America. One of the most valuable gifts of the New World to the Old has been the turkey—the only one of the domestic poultry that is not indigenous to the eastern hemisphere.

5. All the larger land animals, as well as some that are inhabitants of the water, are included by naturalists within the class *mammalia* (animals that suckle their young). The geographical distribution and range of some of the most familiarly known amongst this great division of the animal world are shown on the map ;¹ as, similarly, is the geographical distribution of some of the principal birds and reptiles. The *mammalia* are divided into the *orders* designated—1. Carnivora (*flesh-eating*, as the lion, tiger, dog, &c.) ; 2. Ruminantia (animals that *chew the cud*, as the camel, ox, sheep, &c.) ; 3. Pachydermata (*thick-skinned*, as the elephant, horse, &c.) ; 4. Rodentia (*gnawing*, as the beaver, squirrel, rat, mouse) ; 5. Edentata (*toothless*, as the ant-eater and armadillo) ; 6. Quadrumana (*four-handed*, as apes and monkeys) ; 7. Cheiroptera (*winged-armed*, as bats) ; 8. Marsupialia (*pouched*, as the kangaroo and opossum) ; 9. Cetaceæ (whales and dolphins).²

¹ Maps Nos. 10 and 11, "Physical Atlas for Beginners."

² Latin, *cetus*, a whale.

6. Europe exhibits in its native zoology a less distinctive character than is the case with other continents—a result due to its immediate contact with the vast continent of Asia, whence most of its forms of animal life have been derived. Many of the animals once found within the forests of Europe have been exterminated, or greatly reduced in number, while others have been so altered by generations of domestic training as to have their characteristics greatly modified. The wolf, bear, and wild boar have been entirely banished from the British Islands, though still found in various parts of the continent. The beaver, once common on the banks of British streams, has long since disappeared. The wild ox, the progenitor of our domestic cattle, is now found only in the forests lying east of the Baltic Sea.

7. The *birds* of Europe exhibit greater number and variety of species than its land animals. Aquatic birds, especially, are numerous in its higher latitudes. The stork and the crane belong to western Europe; the pelican, spoon-bill, and scarlet flamingo, to the shores of the Mediterranean.

8. *Reptiles* are few, both in number and species, within this division of the globe. The only venomous serpents are three species of viper, found in the south. Lizards, of which there are numerous species, abound in the same localities.

9. Asia is rich in variety of animal life, and especially so in *mammalia*, nearly all the divisions of which are found within its vast limits. The camel, ox, goat, sheep, as well as numerous species of antelope and deer (all *ruminants*); the horse, ass, elephant and rhinoceros (*pachyderms*); the lion, tiger, leopard, panther, ounce, wolf, hyena, jackal, dog, and fox, with several bears (*carnivora*), all belong to Asia. The varieties of the ox and antelope tribes are marvellously great. The Asiatic lion, however, is now only found within a comparatively limited range, from the banks of the Euphrates eastward to the Indus. The tiger inhabits all middle and south-eastern Asia. The *quadrumana* are found in the south-east, and most *numerously* within the islands of the Malay archipelago, where

the ourang-outang (Malay peninsula, Sumatra, and Borneo), and the gibbons, or long-armed apes, are amongst the wonders of the tropical forest.

10. *Birds*.—Eagles, vultures, falcons, owls, and hawks, are amongst the Asiatic birds of prey (*rapaces*), and most of our domestic poultry came originally from south-eastern Asia.¹ The peacock is a native of India, the golden pheasant belongs to China, and the birds of paradise to New Guinea and the adjacent islands.

11. *Reptiles* are numerous in southern and south-eastern Asia especially in its insular regions. The python (only inferior to the boa-constrictor of the New World) is found within the larger islands of the Malay archipelago, and numerous poisonous snakes in India and elsewhere. The locust, among insects, is the scourge of western Asia, and, in greater or less measure, of the Mediterranean coasts throughout.

12. *Africa* is richer in *mammalia* than any other continent, and especially so in respect of the carnivoras, ruminants, pachyderms, and quadrumana. The lion, panther, leopard, wolf, fox, hyena, and jackal, are among the representatives of its *carnivora*. The numerous species of antelopes and oxen, together with the camel, in the northern half, and the giraffe of southern Africa, take the most prominent places among the *ruminantia*. The elephant, rhinoceros, and hippopotamus; the wild boar, zebra, and quagga; are among the African *pachydermata*. The elephant is dispersed, in immense herds of from one to three hundred, over all the wooded regions of central and southern Africa, and the rhinoceros frequents the same localities. The hippopotamus is found within the upper part of the Nile-valley, and in all the lakes and rivers to the south of the Great Desert. The hippopotamus is *peculiar* to the African continent—that is, it is found in no other division of the globe.

¹ The guinea-fowl, however, is African, and the turkey came originally from America.

13. The African *quadrumanæ* include a numerous variety of monkeys, baboons, apes, and lemurs, which are found in vast numbers throughout this continent. The chimpanzee and the gorilla of its western coasts are among the most remarkable, on account of the resemblance which, in point of structure and external aspect, they present to the human figure. The gorilla inhabits the forests in the neighbourhood of the Gaboon river, close to the equator; the chimpanzee has a much more extended range.

14. *Birds*.—The ostrich is perhaps the most characteristic of African birds, and extends its range from the northern borders of the desert nearly to the opposite extremity of the continent. The woods of tropical Africa abound in parrots and parakeets, with many others of bright and gaudy plumage, as the beautiful sun-birds (which are scarcely larger than the humming-birds of America), together with the golden-coloured orioles, crested hoopoes, bee-eaters, and others.

15. *Reptiles*.—The crocodile inhabits the rivers of tropical Africa, and is abundant in the lower portion of the Nile valley. The huge python, sometimes above twenty feet long (though inferior in size to the boa of the New World), is found in the swamps and morasses of the western coast, and some species of the cobra, or hooked snake, occur, chiefly in southern Africa, and on the shores of Guinea.

16. *Insects* abound in Africa. The termites, or white ants, of western Africa, are among the most destructive members of the insect family—furniture, books, clothes, food, disappearing before their ravages. They build for themselves pyramidal or conical nests, firmly cemented together, and divided into several apartments, so large that at first sight they appear in the distance like the villages of the natives.

17. *Mammalia*.—All the orders of *mammalia* are represented in the zoology of the Western continent. Excepting in the instance of the great white polar bear, which inhabits the high northern latitudes of either hemisphere, and of a few

of the smaller fur-bearing quadrupeds, the native animals of America are of different species from their representatives in the Old World, and are generally of inferior size and powers. In place of the lion, America has only the puma; and the tiger of the Old World is represented by the jaguar, the most formidable of the American *carnivora*.

18. The *ruminants* of the New World include the bison, or American buffalo (a magnificent animal, vast herds of which, though greatly thinned by the hunter, are found within the prairies in the neighbourhood of the Rocky Mountains), with the elk, or moose-deer, the musk-ox, the big-horned sheep, and the Rocky Mountain goat.

19. The South American ruminants include the llama, alpaca, guanaco, all members of the same family, which inhabit the high regions of the Andes, and were early domesticated by the native populations.

20. The tapir and the peccary (both resembling a hog in shape, but the former distinguished by the peculiar form of its snout), are two of the most characteristic of the American *pachyderms*. The peccary is found only in the New World; a tapir of different species is native to Sumatra and the Malay peninsula. Opossums (*marsupialia*) are numerous in South America, and are found as far to the north as Virginia.

21. Of *rodents*, South America has the paca and the agouti (or cutia), which take the place of the hare and rabbit of the Old World, though differing in many particulars from them. Both of these are used as food. The chinchilla, which inhabits the Chilian Andes, is valued for its fur. The sloth, ant-eater, and armadillo, represent the *edentata* of the same continent.

22. The *quadrumana* are most numerous within the Brazilian forests, where the howling-monkeys make the most frightful cries: with the exception of one species, which inhabits the upper part of the Amazon region, all the monkeys

of the New World have long tails. The marmosets, a family peculiar to America, are numerous within the Amazon region.

23. *Birds*.—These rival, in tropical America, the feathered tribes of any other region in point of splendour of plumage; and the condor of the Andes is the largest specimen of the vulture tribe. The toucans (of which there are numerous species, all distinguished by the large size of their bills) are peculiar to tropical America. The family of humming-birds is peculiar to America, and ranges upon its western side from the southern extremity of the continent as far north as the parallel of 60° , though confined on the Atlantic side within much lower limits to the northward.

24. Both *reptiles* and *insects* abound in the New World, over the greater part of which (and especially within its tropical regions) abundant moisture and dense vegetation combine to favour their development. The rattle-snake occurs both in North and South America; the boa-constrictor only within the swamps of the latter. Huge caymans, iguanas, and other lizards, abound in the same region.

25. *Australia* is altogether distinct, in respect of its zoology, from any other division of the globe. Not a single one of its indigenous animals is found native to other lands, and the list of its *mammalia* is more scanty than is the case with any other region. Its largest animal is the kangaroo, which is nowhere found but on the Australian mainland, and the neighbouring island of Tasmania. The marsupial order, to which the kangaroo belongs, is wholly unknown in the continents of the Old World, and is only represented in America by the opossums.

26. Two-thirds of the total number of Australian *mammalia* are marsupials. On the other hand, Australia has no ruminants, no pachyderms, no quadrumana, amongst its native animals. The duck-bill, or platypus, a small animal of semi-aquatic habits, about twelve or thirteen inches long, with the *body of an otter*, a bill like that of a duck, and which lays

eggs, while it also suckles its young, is the most curious and anomalous of the Australian fauna. The fur of the platypus, which ranges from silver-gray to black, is of some value.

27. *Birds*.—Amongst these are a vast variety of the parrot tribe, comprehending paraquets, cockatoos, and others, distinguished by the most beautiful plumage. The birds of prey (*rapaces*), include eagles, falcons, hawks, and owls. The emu, or cassowary, a kind of ostrich, inhabits the interior wilderness, but is rapidly becoming diminished in numbers. A numerous family of honey-suckers takes the place of the humming-birds of America.

28. The native reptiles, insects, and fishes of Australia are equally distinct from those of other lands.

EXAMINATION QUESTIONS.

1. Give some particulars regarding the geographical distribution of animals, noting especially the difference between the animal life of the Old and New Worlds respectively.
2. How are the *mammalia* divided? Name a few typical forms of each order.
3. Give some account of the animals, birds, and reptiles of Europe.
4. Give some particulars of the zoology of Asia.
5. What classes of animals are most abundant in Africa?
6. Name the largest bird and reptile, and most destructive insect, of Africa.
7. What animals in America represent the chief carnivora of the Old World?
8. Name a few distinctive ruminants, pachyderms, rodents, and quadrumana of America.
9. Compare the zoology of Australia and the other great continents,

XV.

GEOGRAPHICAL DISTRIBUTION OF MAN.

1. **Population of the Globe.**—The earth is supposed to contain, at the present time, about fourteen hundred and fifty millions of human beings, distributed in the following manner:—

	Area in British square miles.	Population.	Population to square mile.
Europe	3,700,000	320,000,000	86
Asia	17,000,000	830,000,000	47
Africa	12,000,000	200,000,000	16
North America (including West Indies)..... }	8,600,000	68,000,000	8
South America	7,000,000	28,000,000	4
Oceania.....	3,000,000	4,000,000	1

2. Asia has by much the largest number of inhabitants, absolutely, but Europe is relatively much more populous than Asia—surpassing, in this respect, any other division of the globe. The continents of the New World are very much less populous than the older-known divisions of the globe, though possessing capabilities fully equal to the latter. Australia also is at present but very thinly peopled.

3. Mankind are generally regarded as divided into five great families (or races)—all sprung from a common parentage. These families are distinguished by the terms *Caucasian*, *Mongolian*, *Negro*, *Malay*, and *American*.¹ The distinguishing points of difference between these families are found chiefly in the varying colour of the skin, eyes, and hair, with the curled, lank, woolly, or frizzled condition of the latter; and in the varying shape of the skull, which exhibits a flatter and more receding forehead in the case of the other races than in

¹ Some writers allow only of three varieties—Caucasian, Mongolian, and Negro—regarding the Malay and American as sub-varieties, the former of the *Caucasian*, the latter of the *Mongolian* family.

that of the Caucasian, and departs furthest from the type of the latter in the Negro and the American.

4. **Caucasian Race.**—This term has been employed from the supposition that the neighbourhood of Mount Caucasus exhibits—in the instances of the Circassian and Georgian populations—the most perfect specimens, in so far as mere physical development goes, of mankind. In so far as colour is concerned, the Caucasian is the *white* variety of the human family. Its distinctive attributes are—the oval form of the skull; the face oval, the features moderately prominent, the forehead arched, the cheek-bones slightly projecting, the mouth small, the chin full and round; the skin generally of light colour (varying, however, from white to a deep brown or swarthy hue), the colour of the eyes and hair various, and the latter often curling.

5. In point of geographical distribution, the area over which the Caucasian family is spread in the present day is nearly co-extensive with the habitable globe. Western and south-western Asia, nearly the whole of Europe, and the northern belt of Africa, form their proper home. Thence they have spread, in the course of colonisation, over nearly every part of the New World, as also over southern Africa, with the more distant regions of Australia and New Zealand.

6. **Mongolian Race.**—This variety of the human family is distinguished by a greater squareness in the shape of the skull (viewed from above), with more prominence in the cheek-bones. The forehead is comparatively low and slanting; the face and nose broad and flat; the eye deeply sunk, with the inner corner slanting towards the nose; the complexion of an olive or yellowish-brown colour, the hair lank and black, beard scanty, the stature below the European average, the frame generally broad, square, and robust, with high shoulders, and the neck thick and strong. These attributes are much less strongly marked in the case of some nations of Mongol descent than in others.

7. The name Mongolian, applied to this branch of the family of man, is derived from the nomad races who people the upland plains of Central Asia. It comprehends, besides the Mongols proper, the vast population of China (above a third of the human race), together with the Burmese, Siamese, and other inhabitants of south-eastern Asia, and the native tribes of Siberia. The Turks, Magyars, Finns, Samoyedes, Laplanders, and Esquimaux, are regarded as derived from the Mongol stock. In point of colour it is customary to speak of the Mongol as the *yellow* variety of man.

8. **Negro Race.**—The negro, or *black* variety of the human family, is distinguished not more by the colour of the skin than by the woolly hair, thick lips, and elongated skull, which are among the prominent attributes of the race. The eyes, as well as the skin, are black; the nose broad, flat, and thick; the cheek-bones prominent; the jaws (especially the lower one) narrow and projecting; the palms of the hands and soles of the feet flat; the forms of the arms and lower extremities generally clumsy and ungraceful. Some of these attributes, however, are very greatly modified in the case of many African nations.

9. Africa, south of the desert, is the proper home of the negro race. Nations of the true negro stock occupy by far the larger portion of that continent, and especially of its central portions. Within the basins of the Niger and Lake Chad, however, and also upon the eastern coasts, Arabs have been settled during many centuries. In the extreme south of Africa are the Hottentot and Caffre families, who are generally classed as sub-varieties of the Negro stock, though presenting some well-marked points of difference. The colour of the *Hottentot* is a dark and yellowish brown; the hair short and frizzled, and distributed in tufts; the stature short. The *Caffres* are well made—the limbs of rounded form, the skin of a deep brown colour, the hair short, black, and curly, but *less* woolly than that of the Negro.

10. The Negro race, through the iniquities of the slave trade, has been transplanted from Africa to the other side of the Atlantic, and forms a considerable item in the population of the New World.

11. The native people of Australia and Tasmania (the latter now extinct), with the inhabitants of New Guinea, the Louisiade archipelago, New Britain, the Solomon Islands, New Hebrides, New Caledonia, and the Fiji Islands, are regarded as a sub-variety of the Negro stock, and are classed as *Austral-negroes*, or *Papuans*.

12. **Malay Race.**—Besides the distinguishing attribute of colour, which is *brown*, the Malay family of man have lank, coarse, and black hair, with flattened faces and obliquely-set eyes. Their stature is below that of the Caucasian and Negro varieties.

13. The true Malay family comprehends the inhabitants of the Malay peninsula and the adjacent islands (mixed, in the case of many of the latter, with other tribes), the people of Madagascar, the New Zealanders, and most of the islanders scattered over the vast Pacific, from the Sandwich Islands in the north to New Zealand in the south—including the Society, Navigator, and Friendly groups. It is thus scattered over a vast area, from Madagascar in the west to the Marquesas group in the east (nearly half the globe in the direction of longitude), and from the Sandwich Islands in the north to New Zealand in the south (nearly 70° of latitude). In many of the Polynesian groups, the brown or Malay races are intermixed with tribes of black or Austral-negro stock.

14. **American Race.**—The native races of America, who form the *red*, or copper-coloured, division of mankind, are confined to the New World. Their distinguishing attributes, besides the colour of the skin, are—long, coarse, black hair (never crisped like that of the negro, or curled, as that of the white often is), with scanty beard; the cheek-bones are prominent, but more arched and rounded than in the case of the

Mongol; the eye generally deep sunk, and, as in the race, with a slight obliquity inwards. In point of temper the Indian (as the native inhabitant of the Americas is called) is cold and phlegmatic to an unusual degree, and he manifests an extraordinary insensibility to heat. His senses of sight, hearing, and smell, are remarkable.

15. The native races of South America are in general removed from the higher typical attributes of the human family than those inhabiting the northern division of the World, and they become more and more degraded towards southern extremity. Some of the tribes who dwell in the Brazilian forests exhibit an intense degree of corpulence (produced, in great measure, by artificial means), and the flattening of the head and the prolongation of the lower jaw. The native savages of Tierra del Fuego are among the most mis-shapen and degraded of the human race. These races, as a whole, depart farther from the highest type as they become farther removed from the West, within which the original home of man was planted. The extremes of degradation are found in the native populations of Patagonia and Tierra del Fuego in one direction, and farther south in Australia in another.

EXAMINATION QUESTIONS.

1. What, at the present time, is the estimated population of the earth?
2. Which of the continents has the largest number of inhabitants? Which the next largest number? Which the least number?
3. In which continent is the average number of inhabitants per square mile the largest? In which smallest?
4. Into what five great races are mankind divided?
5. Whence is the term *Caucasian* derived?
6. Over what portions of the world is the Caucasian race distributed at the present time?
7. What are the distinguishing features of the Mongol variety of the human race?
8. What distinguishes the Negro from the other races? In what parts of the world is the Negro race now found?
9. Describe the distinguishing features of the Malayan and American races.

APPENDIX.

THE DISTRIBUTION OF LAND AND WATER.

HEMISPHERES.	LAND.	WATER.
	<i>Square Miles.</i>	<i>Square Miles.</i>
ern Hemisphere	38,000,000	60,500,000
ern Hemisphere	13,500,000	85,000,000
n Hemisphere.....	36,500,000	64,000,000
rn Hemisphere	15,000,000	81,500,000
ental Hemisphere.....	44,000,000	54,500,000
ic Hemisphere.....	7,500,000	90,500,000

LAND AND WATER IN ZONES.

Frigid Zone	2,600,000	5,550,000
Temperate Zone.....	25,150,000	25,950,000
Zone	19,400,000	59,000,000
Temperate Zone.....	4,300,000	46,800,000
Frigid Zone	Unascertained.	

COAST-LINES OF THE CONTINENTS.

	TOTAL LENGTH. ¹	No. of sq. m. of area to one m. of coast.
	<i>Miles.</i>	
.....	19,500	190
.....	85,000	500
.....	16,000	750
America	24,500	350
America	14,500	482
lia	10,000	300

¹ Including the larger indentations only.

THE MOUNTAIN-SYSTEMS OF THE WORLD.

I.—THE MOUNTAIN-SYSTEMS OF EUROPE.

1. IBERIAN SYSTEM.

	<i>Feet.</i>		<i>Feet.</i>
Sierra Nevada, Mulahacen ..	11,660	Castilian Mountains, S. de	
{ Sierra Morena, Aracena ..	5,105	Gredos	8,000
{ Sierra Monchique, Foia....	2,963	{ Sierra d'Estrella	6,540
{ Mts. of Toledo, S. Guadalupe	5,110	Cantabrian Mts., Cerredo ..	8,794
{ Sierra d'Ossa	2,139	Pyrenees, Maladetta	11,168

2. FRENCH SYSTEM.

	<i>Feet.</i>		<i>Feet.</i>
Cevennes, Mount Mezin	5,765	Côte d'Or Mountains,	
Mountains of Auvergne,		Tasselot	1,996
Puy de Sancy	6,187	The Vosges, Ballon d'Alsace	4,154
Mountains of Forez,		Mount Jura, Crêt de la	
Pierre-sur-Haute	5,691	Neige	5,656

3. ALPINE SYSTEM.—I. THE ALPS PROPER.

	<i>Feet.</i>		<i>Feet.</i>
Maritime Alps, Mount Viso ..	12,643	Vierwaldstadter Alps,	
Cottian Alps, Mount Pelvoux	12,973	Galenstock	11,650
Graian Alps, Great Paradis ..	13,271	Swiss Alps, Mount Tödi	11,867
Pennine Alps, Mont Blanc ..	15,781	Rhaetian Alps, Bernina	13,294
Lepontine Alps, Mount Rosa	15,217	Noric Alps, Gross Glockner ..	12,966
Bernese Alps, Finster-aar-		Carnic Alps, Kellerwand	9,500
horn	14,026	Julian Alps, Terglou	10,866
		Dinaric Alps, Mount Kom	9,000

4. ALPINE SYSTEM.—II. SUBORDINATE RANGES.

	<i>Feet.</i>		<i>Feet.</i>
{ Bavarian Alps, Zugspitz ..	9,716	{ Sharra Dagh, Babasanitza	7,462
{ Schwarzwald, Feldburg ..	4,901	{ The Balkans, Koja	5,904
{ Bohmerwald, Arber	4,783	{ Despoto Dagh, Rilo Dagh ..	9,018
{ Erz Gebirge, Keilberg	4,182	{ Mount Pindus, Karavi	6,970
{ Riesen Gebirge, Schneekopf	5,186	{ Mountains of Greece,	
{ Harz Mountains		Liakura	8,250
		{ The Apennines, Monte	
{ The Carpathians, Somnitz	8,779	Corno	9,521
{ Southern Carpathians,		Mountains of Sicily, Etna	10,874
Dzurul	7,574	{ Sardinian Mountains,	
{ Transylvanian Alps, Ruska		Gennargentu	6,132
Poyana	9,912	{ Corsican Mountains,	
		Monte Rotondo	9,069

5. SCANDINAVIAN SYSTEM.

	<i>Feet.</i>		<i>Feet.</i>
Kiolen Mountains, Sulitelma	6,152	Sognefjeld, Shagstlostind....	8,801
Dovrefield, Sneehatten	7,600	Hardangerfjeld, Jöklen	6,533
Ymesfjeld, Galhöppigen	8,546	Gaustafjeld, Gausta	6,174

6. BRITISH SYSTEM.

<i>Scotland.</i>	<i>Feet.</i>	<i>England and Wales.</i>	<i>Feet.</i>
{ Northern Highlands, Ben Attow	4,000	{ Pennine Range, Cross Fell	2,892
Grampians, Ben Nevis	4,406	Cumbrian group, Scaw Fell	3,208
Southern Highlands, Broadlow	2,700	Welsh Mountains, Snowdon	3,571
		Devonian Range, Yea Tor	2,050
<i>Ireland.</i>			<i>Feet.</i>
{ Mountains of Kerry, Carrantuohill.....			3,404
Mountains of Connemara, Mwirea			2,638
Mourne Mountains, Slieve Donard			2,788
Wicklow Hills, Lugnaquilla			3,039

7. URALIAN SYSTEM.

	<i>Feet.</i>		<i>Feet.</i>
Northern Ural, Töll Poss	5,540	Southern Ural, Iremel.....	5,040
Central Ural, Konjakovski ..	5,397		

II.—THE MOUNTAIN-SYSTEMS OF ASIA.

1. WESTERN SYSTEM.

	<i>Feet.</i>		<i>Feet.</i>
The Caucasus, Mt. Elburz..	18,526	Lebanon, Mount Hermon...	10,000
Armenian Mts., Mt. Ararat.	17,260	Sinai Mountains,	
Euxine Hills, Kheshish Dagh	6,332	Arabian Mts., Jebel Akdar.	9,900
Taurus, Bulghar Dagh.....	11,400	Zagros Mts., Kuh Dinar...	13,000
Anti-Taurus, Bingöl Dagh..	11,550	Elburz Mts., Demavend	20,036

2. CENTRAL SYSTEM.

	<i>Feet.</i>		<i>Feet.</i>
Himalaya, Mount Everest ..	29,000	Thian Shan	20,000
Hindu Kush	20,000	Altai Mountains	5,000-7,000

3. EASTERN SYSTEM.

	<i>Feet.</i>		<i>Feet.</i>
Stanovoi Mts., aver. height...	8,500	Pe-ling.....	—
Yablonoi Mts., Sohondo.....	8,300	Nan-ling, some peaks over...	12,000

III.—THE MOUNTAIN-SYSTEMS OF AFRICA.

		<i>Feet.</i>
NORTHERN SYSTEM	Mount Atlas, Miltain	11,400
WESTERN SYSTEM {	Kong Mountains	3,000
	Cameroon Mountains, Mt. Albert	13,760
SOUTHERN SYSTEM {	Sneeuberg, Compassberg	8,000
	Nieuveld	7,000
EASTERN SYSTEM {	Drakenberg, Catkin Peak	10,370
	Lupata Mountains	—
	Livingstone Mountains ..	11,000
	Kenia and Kilimandjaro	each over 20,000

IV.—THE MOUNTAIN-SYSTEMS OF AMERICA.

WESTERN SYSTEM.

		<i>Feet.</i>
Andes.....	Sorata	24,812
Rocky Mountains.....	Mount Brown	15,900
Western Coast Range.....	Mount Fairweather	17,500

EASTERN SYSTEM.

		<i>Feet.</i>
Alleghany System	Black Dome	6,707
Parime System	Mt. Maravaca	10,500
Brazilian System.....	Sierra dos Orgãos	7,700

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Bromide of Magnesium	'008	
Sulphate of Magnesia.....	'023	
Sulphate of Lime	'140	
Carbonate of Lime	'003	}
Iodide and Ammonia	traces	

THE RIVER-SYSTEMS OF THE WORLD.

ARCTIC RIVER-SYSTEM.—EUROPEAN SECTION.

NAME.	Length.	Area of basin.	NAME.	Length.	Area of basin.
	Miles.	Sq. m.		Miles.	Sq. m.
Volga	380	22,000	Mezen	480	47,000
Wina	760	144,000	Petchora.....	900	100,000

ARCTIC RIVER-SYSTEM.—ASIATIC SECTION.

NAME.	Length.	Area of basin.	NAME.	Length.	Area of basin.
	Miles.	Sq. m.		Miles.	Sq. m.
Indigirka	2,600	1250,000	Indigirka	910	86,000
Enisei	2,900	1100,000			
Kolyma	2,500	960,000	Kolyma	800	107,000

ARCTIC RIVER-SYSTEM.—AMERICAN SECTION.

Name.	Length.	Area of basin.
	Miles.	Sq. m.
MacKenzie	2,160	600,000
Yukon	450	(?)
Stikine River	700	(?)

II. THE ATLANTIC RIVER-SYSTEM.

ATLANTIC RIVER-SYSTEM.—EUROPEAN SECTION

NAME.	Length.	Area of basin.
	Miles.	Sq. m.
1.—British Rivers.		
Thames	215	6,160
Trent	180	9,950
Ouse	150	
Tweed	96	1,870
Tay	100	2,400
Severn	200	5,540
Mersey	70	1,748
Clyde	98	1,580
Shannon	224	7,000
2.—Flowing into the Baltic.		
Tornea	350	16,000
Dal	350	11,600
Neva	40	91,000
Dvina	550	45,000
Niemen	400	43,000
Vistula	630	76,000
Oder	550	53,000
3.—Flowing into the North Sea.		
Göta	70	13,700
Glommen	400	16,500
Elbe	600	57,000
Weser	380	17,800
Rhine	760	86,800
Meuse	550	8,700
Scheldt	250	
4.—Flowing into the English Channel.		
Seine	470	30,000
5.—Flowing into the Bay of Biscay.		
Loire	570	48,000
Garonne	350	33,000
6.—Flowing directly into the Atlantic.		
Minho	200	6,300
Douro	460	39,000
Mondago	120	2,700
Tagus	510	34,000
Guadiana	450	26,000
Guadalquivir	290	20,000

ATLANTIC RIVER-SYSTEM.—EUROPEAN SECTION—*continued.*

NAME.	Length.	Area of basin.
<i>7.—Flowing into the Mediterranean.</i>	Miles.	Sq. m.
.....	200	6,500
.....	250	6,400
.....	420	34,000
.....	530	38,000
.....	150	2,900
.....	210	6,300
.....	450	40,000
.....	250	5,600
.....	200	9,500
.....	250	7,400
.....	320	17 500
<i>8. Flowing into the Black Sea—</i>		
.....	1,630	310,000
.....	700	40,000
.....	1,200	200,000
.....	480	23,000
<i>9. Flowing into the Sea of Azov—</i>		
.....	1,100	205,000

ATLANTIC RIVER-SYSTEM.—ASIATIC SECTION.

NAME.	Length.	Area of basin.
<i>10.—Flowing into the Black Sea.</i>	Miles.	Sq. m.
.....	500	30,000
.....	200	—
<i>—Flowing into the Mediterranean.</i>		
.....	230	7,500
.....	230	6,000
.....	250	7,800
.....	200	4,500

ATLANTIC RIVER-SYSTEM.—AFRICAN SECTION.

Name.	Length.	A 1
<i>12.—Flowing into the Mediterranean.</i>		S
	Miles.	
Mulwia	400	
Sheliff	(?)	
Mejerdah	(?)	
Nile	3,000	
<i>13.—Flowing directly into the Atlantic.</i>		S
Senegal	900	
Gambia	650	
Niger	2,300	
Congo	2,900	
Coanza	—	
Orange	1,000	

ATLANTIC RIVER-SYSTEM.—NORTH AMERICAN SECTION.

<i>14.—Flowing into Hudson Bay.</i>		
Churchill	900	
Nelson	400	
<i>15.—Flowing directly into the Atlantic.</i>		4
St. Lawrence	200	
St. John	400	
Connecticut	400	
Hudson	325	
Delaware	300	
Susquehanna	450	
Potomac	400	
James	450	
Roanoke	350	
Pedee	350	
Santee	350	
Savannah	400	
Altamaha	400	
<i>16.—Flowing into the Mexican Gulf.</i>		
Apalachicola	000	
Mobile	550	
Mississippi—		
By main stream	2,400	1,31
By Missouri	4,000	
Grande del Norte	1,400	2

ATLANTIC RIVER-SYSTEM.—SOUTH AMERICAN SECTION.

17.—Flowing into the Caribbean Sea.

Name.	Length.	Area of basin.	Name.	Length.	Area of basin.
	Miles.	Sq. m.		Miles.	Sq. m.
trato	300	11,000	Magdalena	860	98,000

18.—Flowing directly into the Atlantic.

rinoco	1,200	400,000	San Francisco ...	1,500	254,000
assequibo	600	84,000	Grande Belmonde	500	—
emerara	200	3,500	Parahyba	—	—
erbice	360	7,000	La Plata	350	1,240,000
orentyn	470	20,000	Parana	2,800	
urinam	350	12,000	Uruguay	—	—
laroni	400	18,000	Colorado	600	—
mazon	3,900	2,500,000	Negro	800	—
laranhao	360	—	Chupat	—	—
aranhyba	750	—	Santa Cruz.....	—	—

III.—THE PACIFIC RIVER-SYSTEM.

AMERICAN SECTION.

NAME.	Length.	Area of basin.	NAME.	Length.	Area of basin.
	Miles.	Sq. m.		Miles.	Sq. m.
ukon	2,000	—	Colorado	1,100	230,000
raser	600	98,000	Biobio	190	—
olumbia	750	265,000	Maypu.....	160	—
acramento	420	63,000			

ASIATIC SECTION.

	Miles.		Miles.
mur	2,300	Choo-kiang.....	1,100
oang-ho	2,600	Mekon	1,600
ang-tsze-kiang	3,200	Menam	900

AUSTRALIAN SECTION.

risbane	200	Hunter	170
larence	—	Shoalhaven	230

IV.—THE RIVER-SYSTEM OF THE INDIAN OCEAN.
AUSTRALIAN SECTION.

NAME.		NAME.	
	Miles.		Miles.
Murray	1,760	Roper nav. for	100
Swan	200	Flinders	—
Victoria	—	Mitchell	—

ASIATIC SECTION.

NAME.		NAME.	
	Miles.		Miles.
Saluen	700	Krishna	800
Irawadi	1,200	Cauvery	470
Brahmaputra	1,800	Nerbudda	900
Ganges	1,960	Indus	1,700
Mahanuddy	500	Euphrates	1,740
Godavery	900	Tigris	1,180

AFRICAN SECTION.

NAME.		NAME.	
			Miles.
Rufiji	—	Zambesi	2,850
Rovuma	—	Limpopo	600

THE CHIEF LAKES OF THE WORLD.

The principal lakes in each division of the globe, classified as they are salt or fresh, are enumerated in the following

The figures in the first column give the area of each lake in square miles: those in the second column its elevation above level in feet; or, in the instances where the sign minus (—) is, its depression below that level:—

SALT LAKES.

1 (Russia, } 2, Turke- }	130,000	—	83	Kof-hissar (Asia Minor)	570	2,858
				Dead Sea (Syria)	360—	1,200
Russia, } estan }	26,000		31	Balaton, or Platten See } (Hungary)	250	918
h (Russia) .	7,000			Nieusiedler See (Hun- } gary)	150	350
yah (Persia) .	1,800	4,300		Ielton (Russia) .	130	
siatic Turkey)	1,600	5,647		Keroun (Egypt) .	130	
nor (Tibet) .	1,800			Assal (Abyssinia) .	30	— 570
or (do.) .	1,500			Shirwa (East Africa)	900	1,800
ineseTurkestan)	1,300			Great Salt Lake (United } States)	1,800	4,200
gaun (Persia) .	520			Uros (Bolivia) .	2,000	12,357
(Afghanistan) .	1,600					

FRESH-WATER LAKES.

IN EUROPE.						
(Russia) .	6,330			Lucerne, (Switzerland)	99	1,430
do. .	3,230			Zurich do. .	76	1,332
Sweden) .	2,136	144		Corrib (Ireland) .	68	31
Russia) .	2,000			Como (Italy) .	66	684
do. .	1,250			Thun (Switzerland) .	22	1,824
do. .	1,200			Brienx do. .	15	1,850
(Sweden) .	840	288		Erne (Ireland) .	57	150
do. .	760	8		Derg do. .	46	110
Russia) .	420			Lomond (Scotland) .	45	22
do. .	390			Ree (Ireland) .	41	125
(Norway) .	300	420		Mask do. .	35	65
Switzerland)	240	1,230		Awe (Scotland). .	25	
ce do. .	228	1,299		Marce do. .	30	
(Italy) .	183	320		Tay do. .	15	
a do. .	152	678		Windermere (England)	11	116
(Ireland) .	150	48		Ulleswater do. .	6	818
stel (Switzer- } do. . }	115	1,437		Killarney (Ireland) .	10	68

FRESH-WATER LAKES—*continued*

IN ASIA.			IN AMERICA.		
Baikal (Siberia) .	14,800	1,798	Superior (United States, Canada) .	32,000	
Kossogol (Mongolia) .	4,500	5,600	Michigan (Untd. States) .	24,000	
Tong-ting (China) .	2,000		Huron (Untd. States, Canada) .	20,000	
Zaisang (Chinese Turkestan) .	1,800		Erie do. do. .	9,600	
Poyang (China) .	800		Ontario do. do. .	6,800	
Tai-hou do. .	700		Champlain (United States) .	500	
Bouka-nor (Tibet) .	1,000		Great Slave (Hudson Bay Territory) .	12,000	
Goukcha, or Sevan (Russian Armenia) .	500	6,800	Great Bear do. .	10,000	
Tiberias (Syria) .	76	—328	Winnipeg do. .	9,000	
Manasarowar (Tibet) .	150	15,000	Winnipegosis do. .	3,000	
Rakas Tai do. .	120	15,000	Athabasca do. .	3,000	
Palte do. .		13,500	Deer L. do. .	2,400	
Iasyk (Russian Turkestan) .	1,500	5,000	Manitoba do. .	2,100	
Sir-i-kol (Independent Turkestan) .	14	15,000	Wollaston do. .	1,900	
IN AFRICA.			Lake of the Woods .	1,500	
Chad (Soudan) .		850	Utah (United States) .	150	4
Tzana, or Dembea, (Abyssinia) .	1,400	6,270	Nicaragua (Central America) .	3,500	
Victoria Nyanza (Equatorial Africa) .		3,308	Managua do. .	430	
Albert Nyanza do. .		2,720	Yojca do. .	150	2
Tanganyika (South Africa) .	10,000	1,800	Chapala (Mexico) .	1,000	
Nyassa do. .		1,800	Titicaca (Peru and Bolivia) .	3,800	12
Ngami do. .		2,930	Patos (Brazil) .	5,000	


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